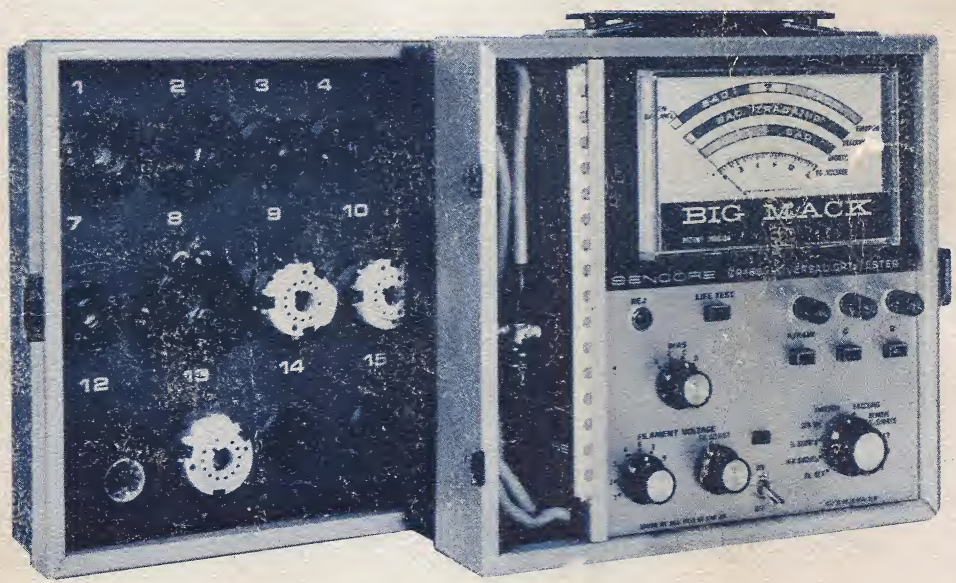
CR168
BIG MACK
UNIVERSAL
CRT TESTER
SERVICE MANUAL



SENCORE

"the all american line"

SAFETY REMINDERS

When testing electronic equipment, there is always a danger present. Unexpected high voltages can be present at unusual locations in defective equipment. The technician should become familiar with the device that he is working on and observe the following precautions.

1. The CR168 should be connected to the CRT under test only after the receiver has been turned off, and all high voltage circuits discharged.

2. Care should be taken when working with the fragile glass neck of a CRT, because of the possible danger of an iimploding CRT.

3. When making test lead connections to high voltage points, remove the power. If this cannot be done, be sure to avoid contact with other equipment or metal objects. Place one hand in your pocket as a safety precaution and stand on an insulated floor to reduce the possibility of shock.

4. Be sure your equipment is in good order. Broken or frayed test leads can be extremely dangerous and can expose the technician to dangerous potentials.

5. Remove the test leads immediately after the test has been completed to reduce the possibility of shock.

6. Do not work alone when working on hazardous circuits. Always have another person close by in case of accident. Remember, even a minor shock can be the cause of a more serious accident, such as falling against the equipment, or coming in contact with high voltages.

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DESCRIPTION

INTRODUCTION

Consumer pressure for larger screen sizes in portable cabinets, and brighter pictures along with TV receiver circuit design innovations have resulted in new color CRT types being introduced at an unprecedented rate.

New CRT bases for 110 degree deflection systems, as well as in line and single gun structures have rendered nearly every CRT tester now on the market obsolete. Sencore engineering recognized the need for a truly universal CRT tester that would be adaptable to any conceivable CRT base.

Another problem recognized by Sencore engineers was the difficulty in convincing your customer of the need for a costly CRT replacement. Testers that require a different test for black and white CRT's standard color CRT's and single gun CRT's are too confusing to effectively explain test results to the untrained customer.

The answer to both of these problems is the CR168 Universal CRT Analyzer. The CR168 provides instant adaptability to any CRT base with new individual numbered CRT adapters. All tubes are tested with the same test procedure, and all test results are read out on the large 6 inch meter. Even the most skeptical customer will instantly see the need for a CRT replacement when he sees the tests performed on the CR168. In addition, the CR168 incorporates the Sencore patented (3688184) Automatic tracking test for the fastest, most accurate test possible on color CRT's. Check the features and specifications, and compare. The CR168 is the only truly Universal Automatic CRT Analyzer.

FEATURES

* Patented Automatic Tracking test
* Large 6" Meter
* Metered Shorts Test. No confusing or hard to see lights
* Universal test for all black and white, tri color, and single gun CRT's
* Individual, numbered, easy to use socket adapters

Fig. 1 CR168 Universal CRT Tester

SPECIFICATIONS

FILAMENT VOLTAGE

Continuously variable from 1 - 14 volts
Meter accuracy ± 5%

SHORTS TEST

H-K Shorts - 2 Meg sensitivity 20%
G1 Shorts - 20 Meg sensitivity 20%

EMISSION

Measures zero bias beam for CRT under test

Meter Sensitivity
Low end of GOOD: 300uA, 5%
High end of BAD: 200uA, 5%

TRACKING

Ratio of 1.55 to 1 ± 10%, or greater will indicate BAD tracking.

GENERAL

Meter: 6", 500uA, 2%, 225 ohms
Size: 10¾" (27.3cm) H x 11½" (29.2cm) W x 7" (17.7cm) D
Weight: 14 lbs. (6.4kg)
Power requirements: 105-130 VAC 50/60Hz

CONTROLS

ON-OFF: This toggle switch controls the AC input power to the CR168. The ON condition is indicated by the red neon indicator above the switch.

FILAMENT VOLTAGE: The rotary switch and wire wound control are used in conjunction with the FIL. VOLTAGE scale on the meter. Together they provide precise adjustment of the filament voltage for the CRT under test.

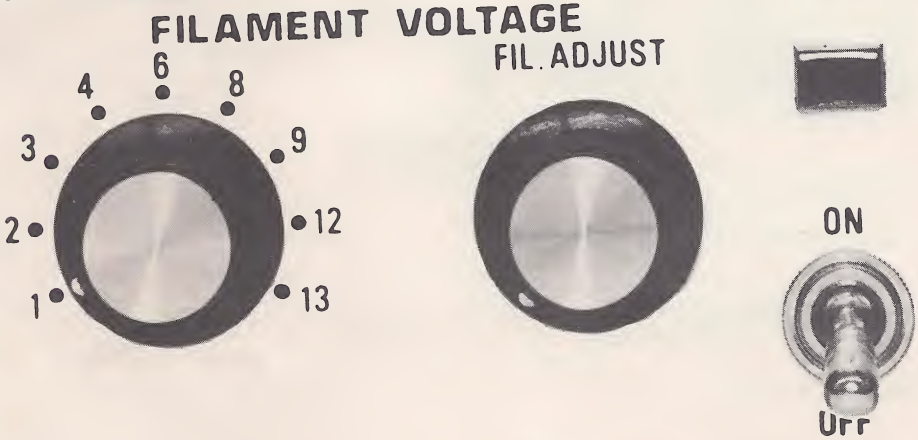


Fig. 2 CR168 On-Off and Filament Voltage controls

FUNCTION: This rotary switch selects the test to be performed on the CRT. The order of the tests on the function switch is in the same sequence used to test CRT.

Fig. 3 CR168 Function Switch

BIAS: This rotary switch selects the negative G1 bias voltage applied to the tube. The A setting corresponds to a bias of 20; B-35; C-50; and D-70 volts. The correct setting for this switch is found in the CR168 Set Up Book.

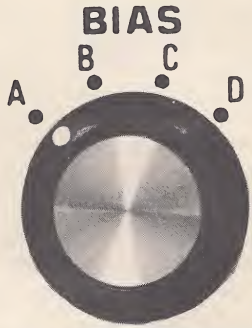


Fig. 4 CR168 Bias Switch

REJ: This momentary contact pushbutton is used to apply the rejuvenation or shorts removal voltage to the CRT during these restoration functions.

LIFE TEST: This momentary contact pushbutton switch reduces the filament voltage, by approximately 15%, to permit testing for CRT's that are sensitive to lowered filament voltage.

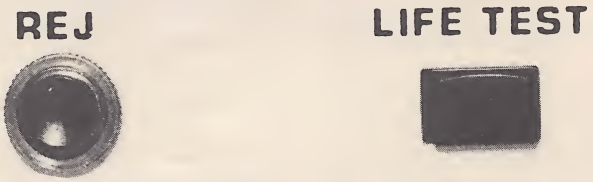


Fig. 5 CR168 REJ and Life Test buttons

GUN SELECTOR: The three pushbutton switches above the Function switch select the gun to be tested. The first button (R/B&W) is to be used for testing black and white CRT's and the Red gun of color tubes. The second button (G) selects the green gun of color CRT's and the third button (B) the bule gun.

G2 or GUN BALANCE: The three controls above the Gun Selector pushbuttons control the G2 voltage applied to the CRT during the GUN BALANCE, EMISSION, and TRACKING tests. The first control (R/B&W) adjusts G2 voltage for the red gun of color CRT's, and all black and white tubes. The second (G) adjusts the G2 voltage for the green gun of color CRT's, and the third, (B), the blue gun.

Fig. 6 CR168 Gun Balance and Gun Selector

CRT ADAPTORS

The CR168 uses individual numbered socket adaptors arranged in the cover in numerical order. The CR168 Set Up Book lists the correct socket for the tube to be tested. To remove a socket adaptor, simply pull it from its plastic holder. To replace the adaptor after use, push it into the holder, taking care to line up the pins with the holes in the holder.

OPERATION

SET UP

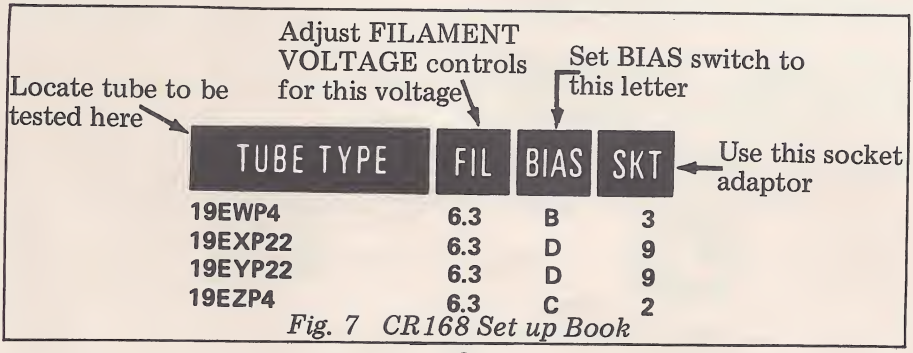


Fig. 7 CR168 Set up Book

Locate the type number of the CRT to be tested in the CR168 Set Up Book. Tubes are listed first in numerical order by screen size, (i.e. 12, 17, 19, 21) and second in alphabetical order of the letters following the screen size. For convenience, both black and white and color CRT's are contained in the same listing. The tabs in the set up book list the last tube on that page.

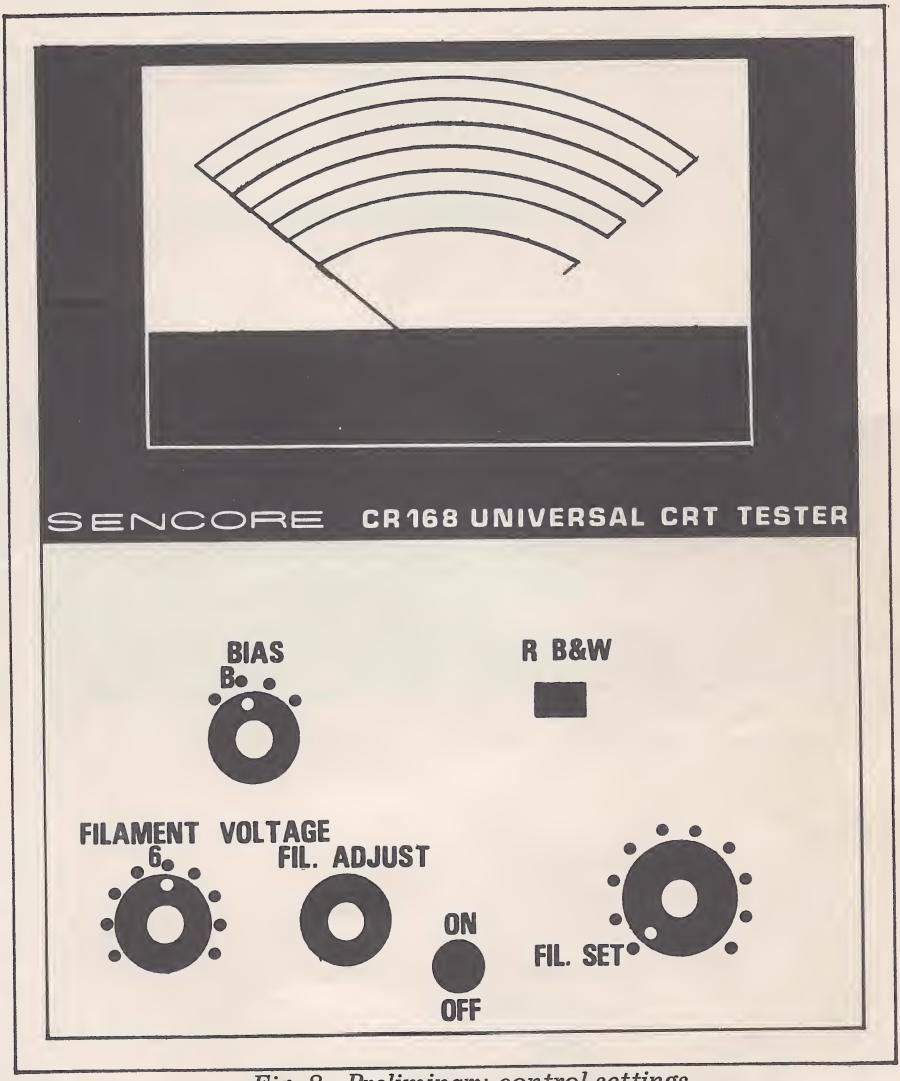


Fig. 8 Preliminary control settings

Set the coarse FILAMENT VOLTAGE switch to the value nearest that listed in the Set Up Book, and turn the FIL. ADJUST control fully counterclockwise. Set the BIAS switch to the correct position as indi-

cated in the Set Up Book. Rotate the G2 controls fully counterclockwise, press the R/B&W Gun Selector pushbutton, and set the function switch to FIL SET position. Select the correct socket adaptor as indicated in the set Up Book, and plug it into the adaptor cable.

CONNECTION

Remove power from the equipment containing the CRT to be tested, and discharge the second anode of the CRT. NOTE: A severe shock hazard and possible damage to the CR168 will result if an attempt is made to test a CRT with second anode voltage applied.

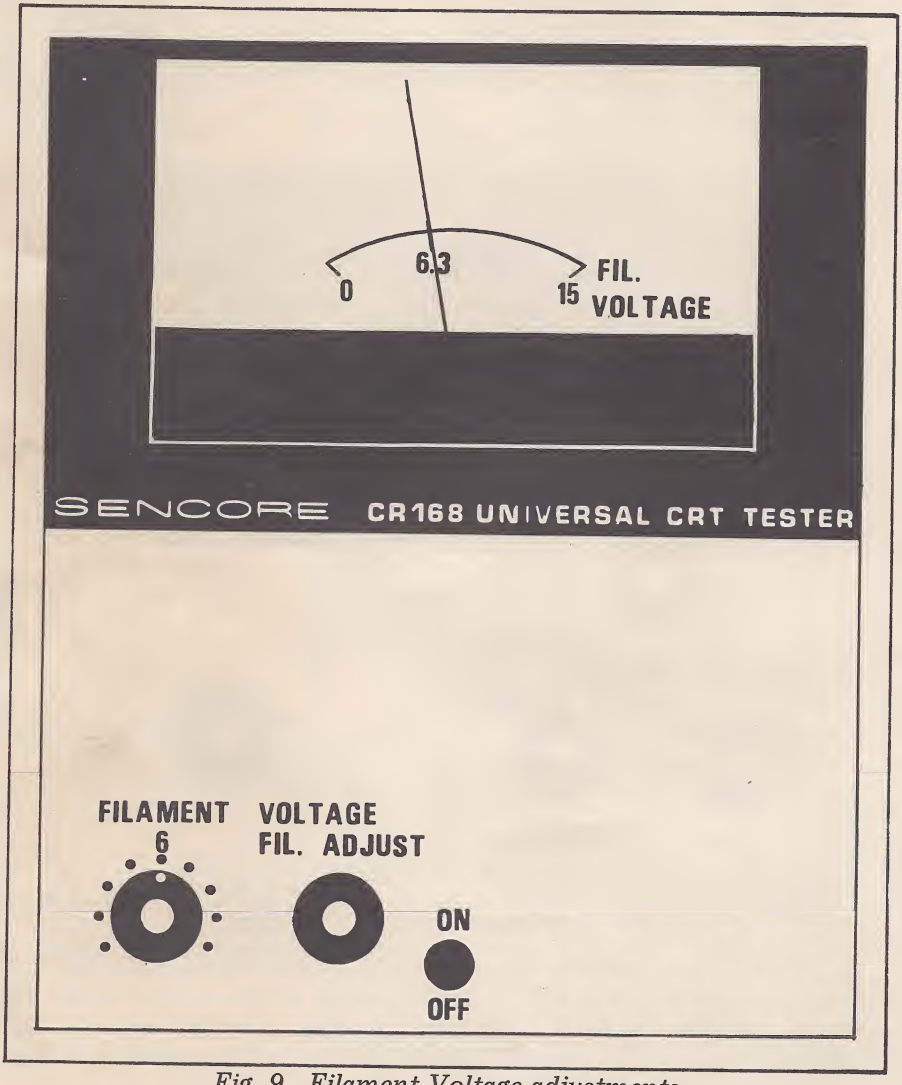


Fig. 9 Filament Voltage adjustments

Connect the socket adaptor to the base of the CRT. Take care to align the keyway properly, to eliminate possible damage to the pins of the CRT.

TEST

ADJUST FILAMENT VOLTAGE

Rotate the FIL. ADJUST control, observing FIL. VOLTAGE scale on meter, until the exact voltage listed in the Set Up Book is indicated. Wait 30 seconds to allow tube warm-up, and readjust. The filament voltage will stabilize when the filament of the CRT has reached its normal operating temperature.

CHECKING FOR SHORTS

The shorts tests on the CR168 have been designed to test for all shorts and leakages that will be encountered in color or black and white CRT's. The H-K SHORTS test will indicate any short or leakage existing between heater and cathode, cathode and G2, or G1 and G2. The dividing line between the GOOD and BAD portions of the SHORTS scale represent a leakage value of 2 megohms for this test. The G1 SHORTS test will indicate any short or leakage existing between cathode and G1, or G1 and G2. The dividing line between the GOOD and BAD portions of the SHORTS scale of the meter represents a leakage value of 20 megohms for this test. The sensitive shorts tests, coupled with a meter readout rather than other indicating devices, allows complete and accurate shorts testing of any CRT. Minute leakages of 50 to 100 megohms or greater will be indicated, but will cause a reading in the GOOD portion of the scale. If the meter indication is in the upper portion of the GOOD scale, it is suggested that the filament voltage be raised approximately 10% to determine if the short or leakage becomes more pronounced. An increase in the upscale reading, or an indication in the BAD portion of the scale, will indicate a leakage condition which will become increasingly worse as the tube ages. A BAD indication when testing the tube with normal filament voltage should be cause to replace the tube or attempt shorts removal as explained in the next section.

1. Depress R/B&W Gun Selector pushbutton. Rotate Function switch to H-K SHORTS position and observe SHORTS scale on meter. Repeat with the G and B pushbuttons depressed for full test of a color CRT.

2. Rotate Function Switch to G1 SHORTS and observe SHORTS scale on meter. Depress G and B pushbuttons for complete color tube shorts test.

3. Exact location of the short, and possible corrective action, can be determined as follows:

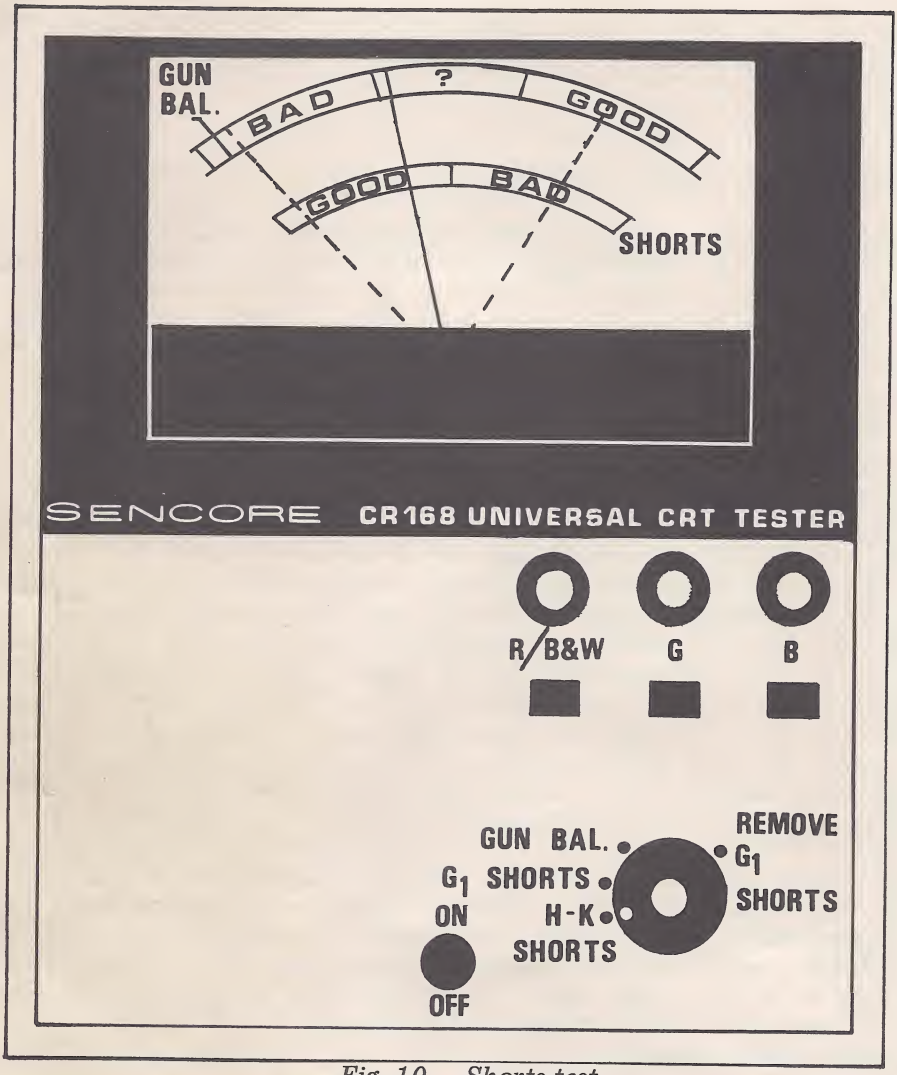


Fig. 10 Shorts test

A. If a short is indicated in both H-K and G1 SHORTS, the short exists between G1 and G2. In most cases it will be possible to remove a G1 to G2 short with the CR168 REMOVE G1 SHORTS function. Switch the CR168 OFF and refer to section on REMOVE G1 SHORTS.

B. If a short is indicated in H-K only, the short may exist between heater and cathode, or cathode and G2. To determine if a short exists between cathode and G2, turn the G2 control for the gun showing short fully counterclockwise, turn the Function Switch to the GUN BALANCE position, and observe the SHORTS scale on the meter. If the meter indicates into the BAD area of the SHORTS scale, the short exists between

cathode and G2, and can not be removed or corrected. If the meter indicates in the GOOD area of the SHORTS scale, the short exists between heater and cathode, and may be corrected through the use of an "isolation" type of brightener.

C. If a short is indicated in G1 SHORTS only, the short exists between cathode and G1. In most cases it will be possible to remove a cathode to G1 short with the CR168 REMOVE G1 SHORTS function. Switch CR168 OFF and refer to section on REMOVE G1 SHORTS.

GUN BALANCE

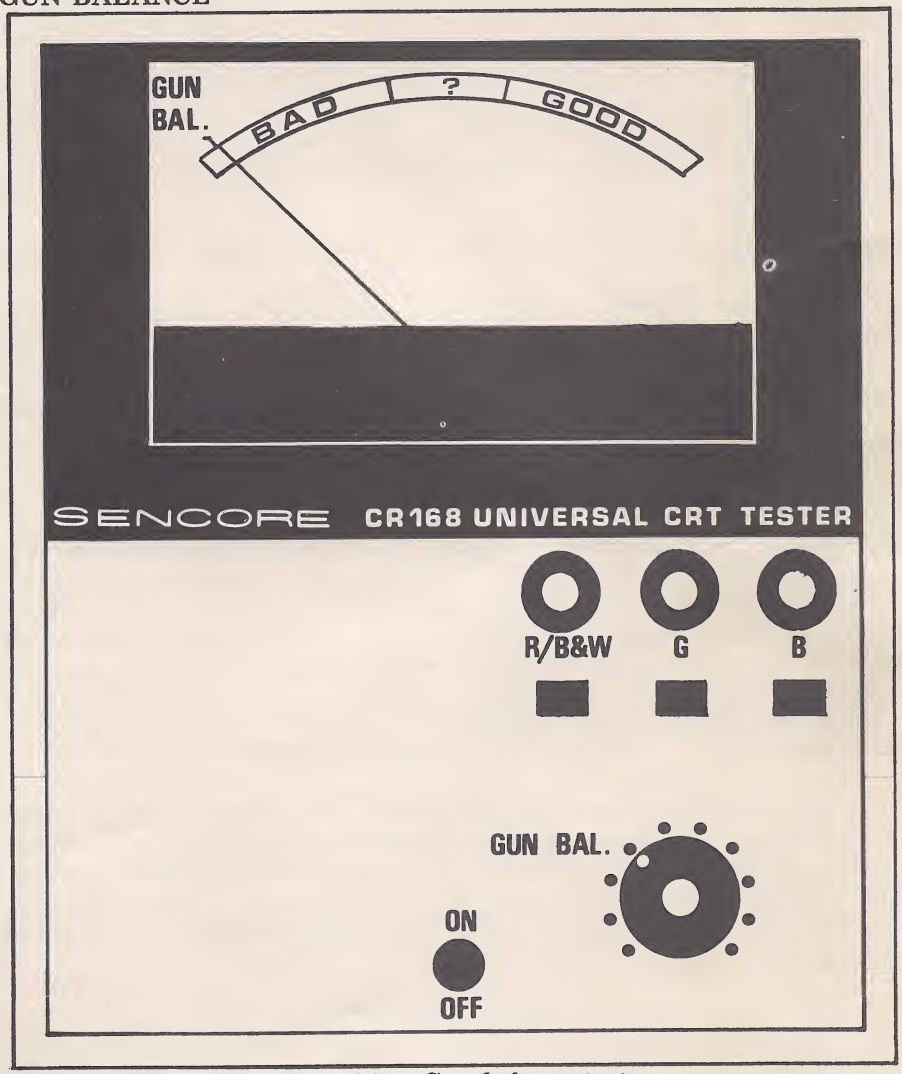


Fig. 11 Gun balance test

1. Depress the R/B&W Gun Selector pushbutton, and rotate the Function switch to the GUN BALANCE position.

2. Adjust the R/B&W control to position the meter pointer to the GUN BALANCE line on the meter. Repeat Gun Balance for each gun of a color CRT by adjusting the Green G2 control for balance with G pushbutton depressed, and adjusting Blue G2 with B pushbutton depressed. Recheck the settings of the G2 controls to be sure that all three guns are accurately adjusted to the GUN BALANCE line on the meter. (If the guns of a color tube are not balanced properly, the results of the emission and color tracking tests will not be reliable.)

NOTE: A tube that fails to adjust to the GUN BALANCE line should be considered questionable, regardless of the results of the EMISSION and TRACKING tests. Tubes that fail this GUN BALANCE test do not meet the manufacturers specifications for grid cut off range, and will usually show poor contrast (reduced dynamic range). Color CRT's that fail the GUN BALANCE test may also exhibit gray scale set-up problems in some receivers.

CHECK EMISSION

Depress the R/B&W Gun Selector pushbutton, and rotate the Function Switch to the EMISSION position. Observe the tube condition on the BAD-?-GOOD EMISSION scale of the meter. Repeat the EMISSION test with the G and B pushbuttons depressed for a complete test of color CRT's.

NOTES ON EMISSION TEST

1. Many CRT's will develop a large space charge around the cathode during preliminary SHORTS and GUN BALANCE tests, due to the heating of the cathode. This space charge will cause a higher than normal initial emission reading. The level of emission will decrease to the actual emission of the tube after the space charge has been depleated, approximately 60 seconds after switching to emission test for that gun. To be sure of accurate test results, especially on color CRT's, allow the emission reading to reach its final value before testing other guns.

2. Any color CRT containing a gun that indicates in the questionable or BAD area of the meter on the emission test, should be considered defective and the tube replaced or corrective action taken to restore weak guns. The results of the Tracking test, if performed, would be invalid. The Tracking test is designed to determine tracking ability of color tubes passing emission test.

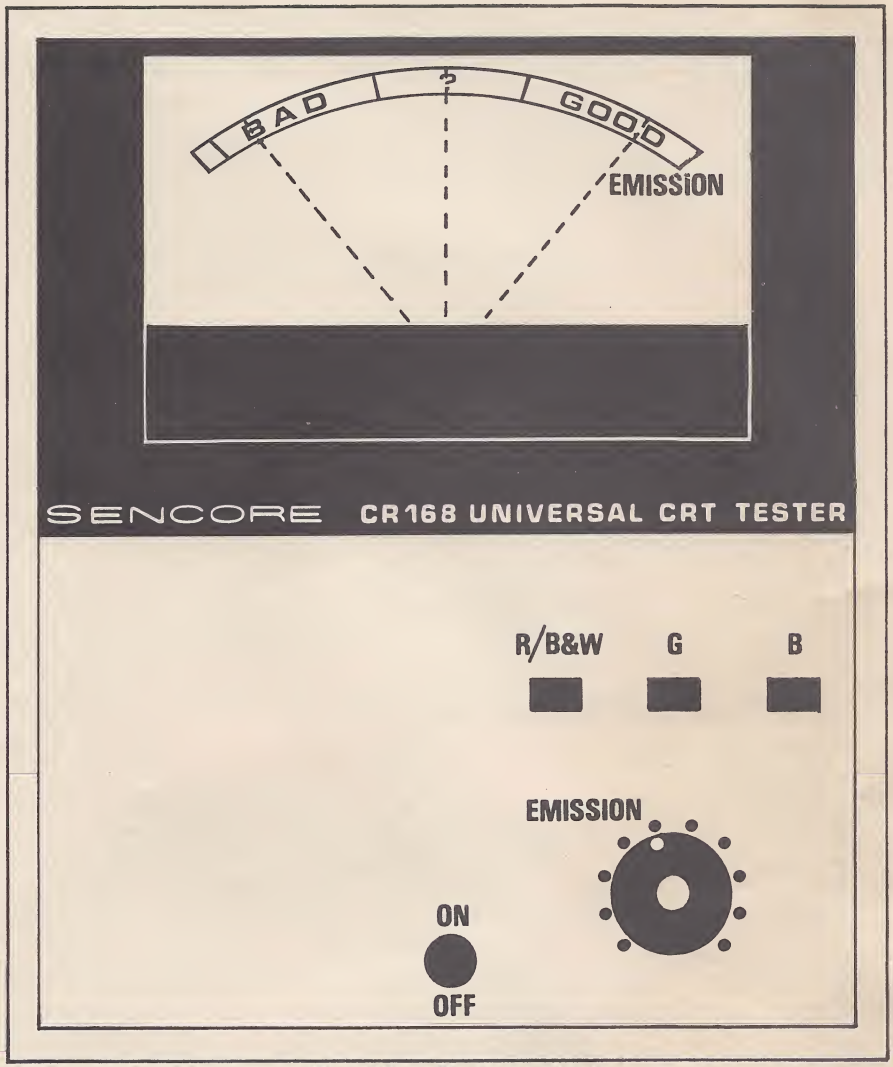


Fig. 12 Emission test

LIFE TEST

The life test is a measurement of the reserve emission, or life remaining in a CRT. As a tube ages, the reserve emission decreases, so that an older tube capable of a maximum emission of 400uA would have a much smaller reserve, and a shorter life expectancy than a new tube. The curve in Fig. 12A, shows the emission Vs filament voltage characteristics of a good tube as tested on the CR168. Note that the emission of 1.16mA at 6.3 volts filament is relatively constant from 5.8 to 7.4 volts, and drops only to 1.1mA at the life test voltage of 5.4 volts.

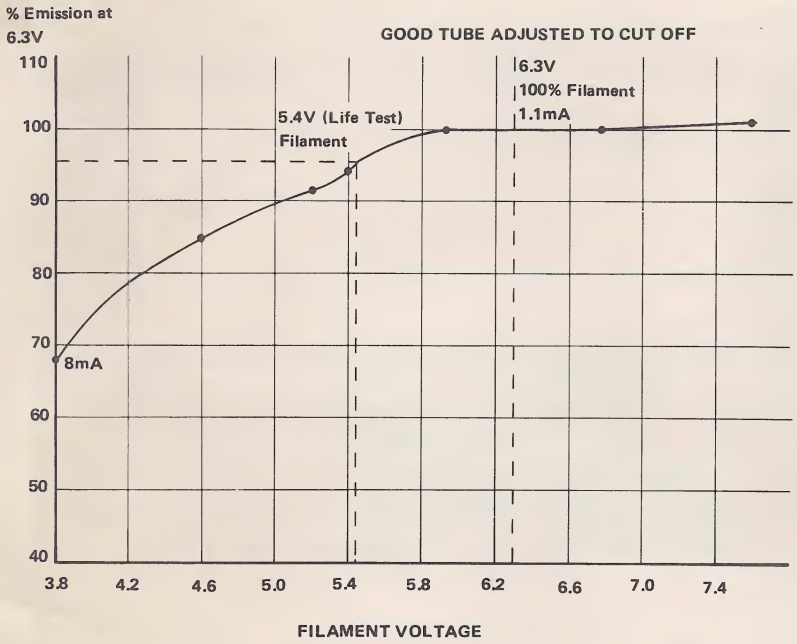
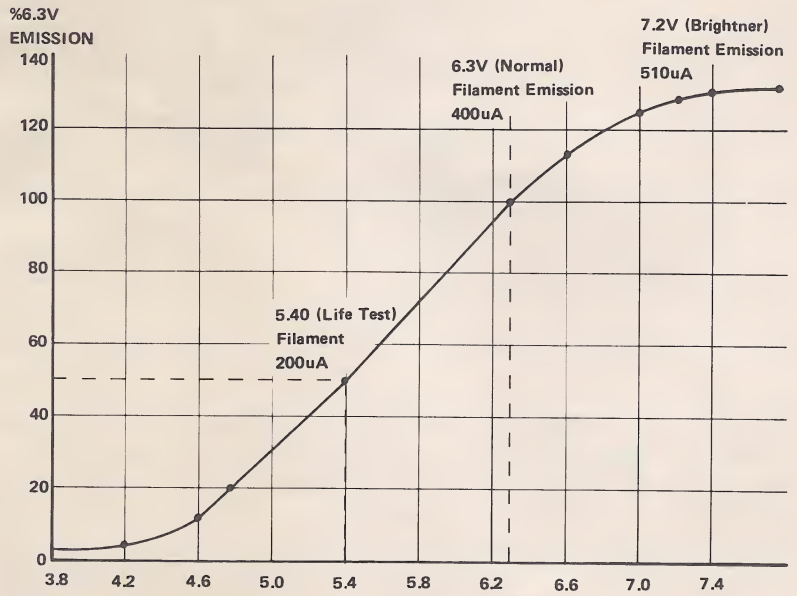


Fig. 13 Emission vs Filament voltage for A - good CRT, B - Bad CRT



The curve in Fig. 12B, shows the emission characteristics of a tube that would fail the life test. The emission of 400uA at 6.3 volts is still well inside the GOOD area of the CR168 meter, but at the life test filament voltage of 5.4 volts, the emission has dropped 50% to 200uA or into the BAD area of the meter. Note that at the brightener filament of 7.2 volts the emission has increased to 510uA, and has stabilized at that level. This would indicate that the addition of a brightener would prolong the useful life of this tube. To perform the normal life test, proceed as follows:

1. Perform the standard test on the CRT using the filament voltage listed in the CR168 Set Up Book.

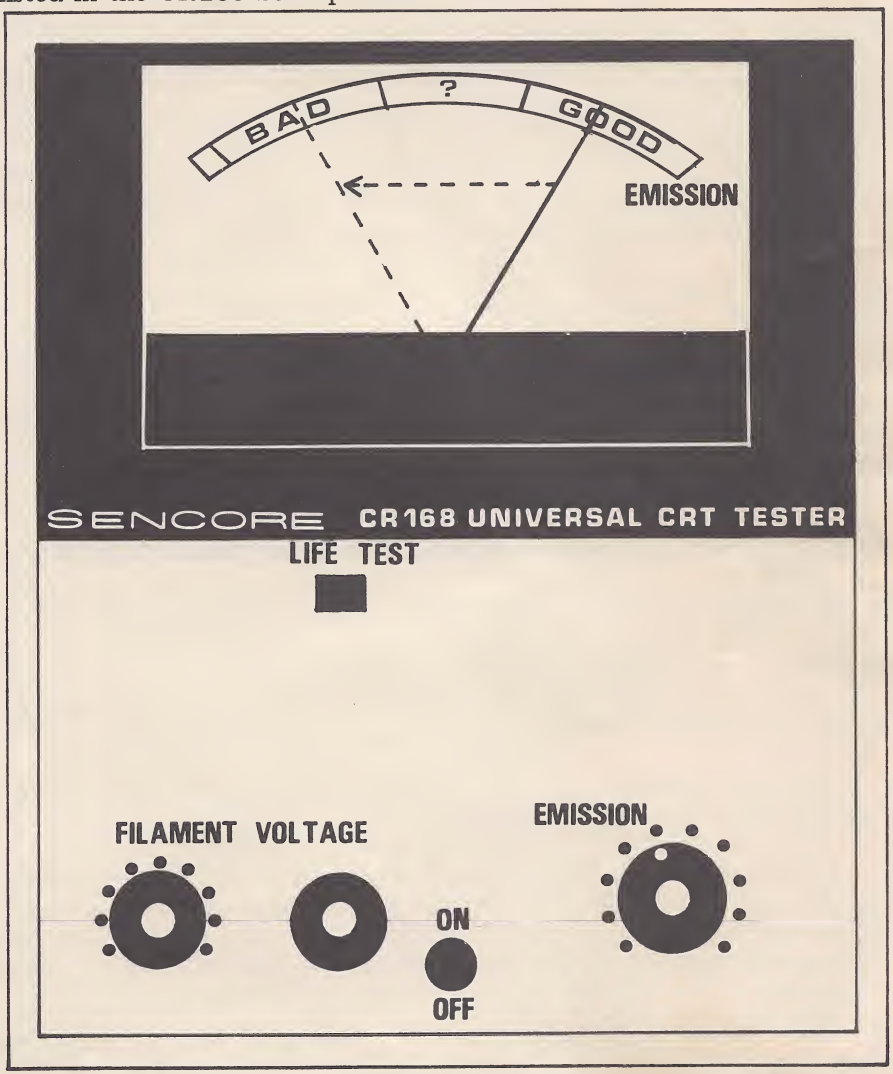


Fig. 14 Life Test

2. Turn the Function Switch to the EMISSION position, press the LIFE TEST button, and observe the EMISSION scale on the meter. A tube with good life expectancy will indicate nearly the same emission with the life test button pushed, as with normal filament voltage applied. A tube with poor life expectancy will indicate lower emission with the LIFE TEST button pushed. A tube whose emission falls off rapidly, or one that reads in the BAD area of the EMISSION scale after the LIFE TEST button has been depressed 60 seconds has failed the life test, and should be replaced or a brightener installed.

EXPANDED LIFE TEST

The purpose of the expanded life test is to determine if a CRT operating at a consistantly low filament voltage, will produce an acceptable picture. To make the expanded life test, adjust the CR168 FILAMENT VOLTAGE controls for a voltage 15% less than listed in the CR168 Set Up Book. Repeat the SHORTS, GUN BALANCE, EMISSION, and TRACKING tests. If the CRT fails the expanded life test, an auto-transformer should be used to raise the line voltage to a normal level, or a brightener added to the CRT to raise its filament voltage closer to normal.

TRACKING TEST

The Tri-gun CRT requires an additional test not necessary on single gun black and white CRT's. If the color CRT is to produce a good gray scale from low to high brightness, the ratio of the emissions of any two guns can not exceed 1.5 to 1. The exclusive patented (3688184) Sencore automatic tracking test automatically compares the emissions of all three guns for the 1.5 to 1 ratio.

NOTE: The accuracy of the TRACKING test will depend on the care with which the GUN BALANCE and EMISSION tests were performed. Be sure to read notes 1 and 2 on testing emission before performing the color tracking test. If anything is done to change the CRT, such as rejuvenation, or increasing the filament voltage to determine the effect of a brightener, the GUN BALANCE and EMISSION tests must be repeated before rechecking the tracking.

1. Without touching the Gun Selector switches, turn the Function Switch to the TRACKING position.

2. Observe the TRACKING scale on the meter. The meter will indicate zero for a good CRT. A CRT with questionable tracking will indicate in the white area of the TRACKING scale, and a CRT with bad tracking will indicate in the red BAD area of the TRACKING scale.

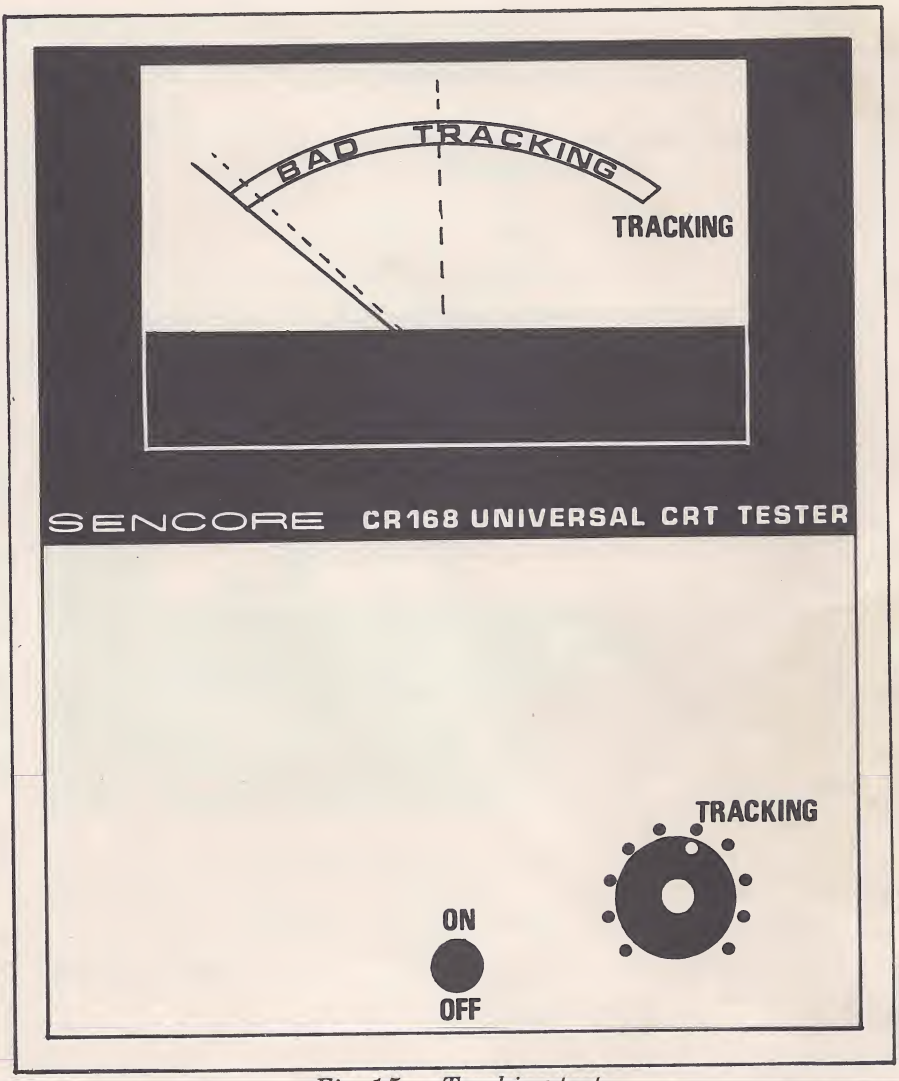


Fig. 15 Tracking test

CRT RESTORATION FUNCTIONS

CORRECTING BAD TRACKING

REJUVENATION

1. Turn the Function switch back to the Emission position, and observe the EMISSION reading for all three guns.

2. Push the Gun Selector Switch corresponding to the gun with the lowest emission reading, and turn the Function Switch to one of the rejuvenation functions. (SEE REJUVENATION)

3. After attempting rejuvenation, be sure to go back to the SHORTS tests and completely recheck the CRT.

WITH A BRIGHTENER

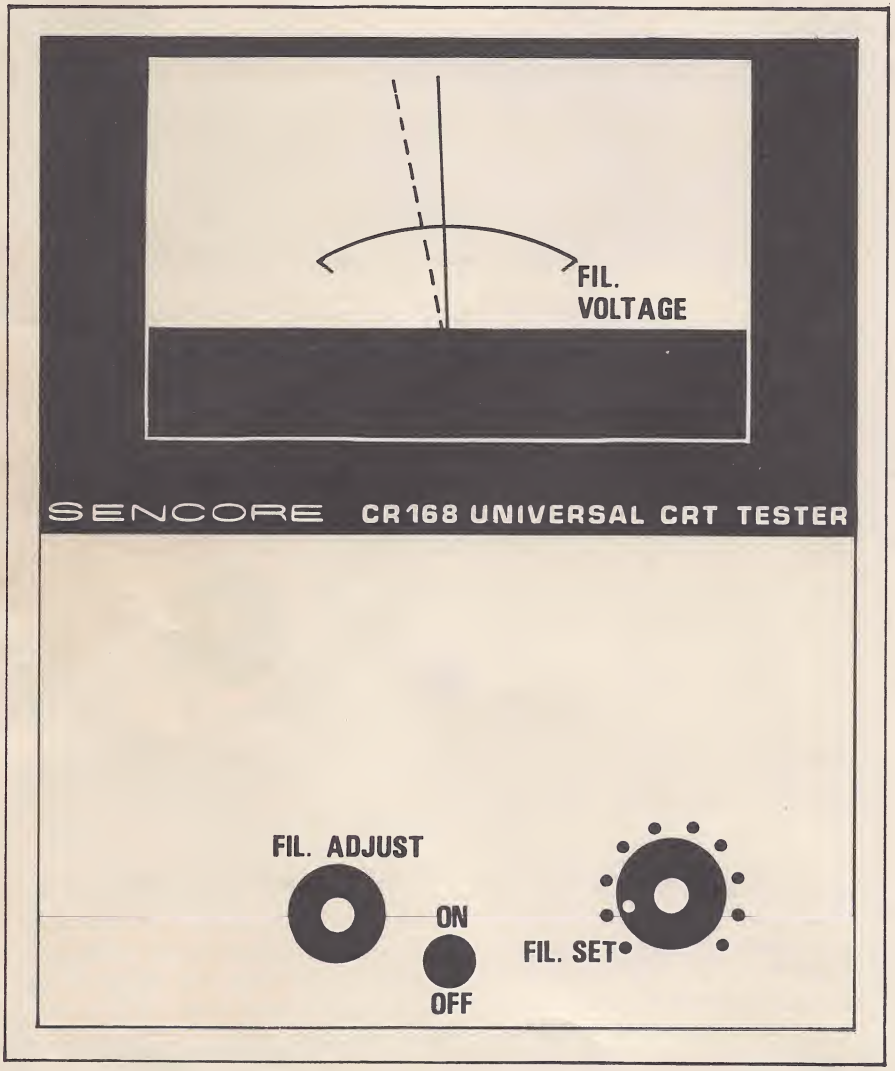


Fig. 16 Simulating the action of a brightener

1. Turn the Function Switch to the SET FILAMENT position, and increase the filament voltage by approximately 10%.

2. Recheck the CRT at the elevated filament voltage. If it checks good on all tests, the addition of a brightener should restore acceptable performance.

REMOVE G1 SHORTS

If a G1 short is indicated by the Shorts test it is generally possible to remove it with the CR168. The CR168 REMOVE G1 SHORTS function applies the charge stored on a 125uF 450 volt electrolytic capacitor

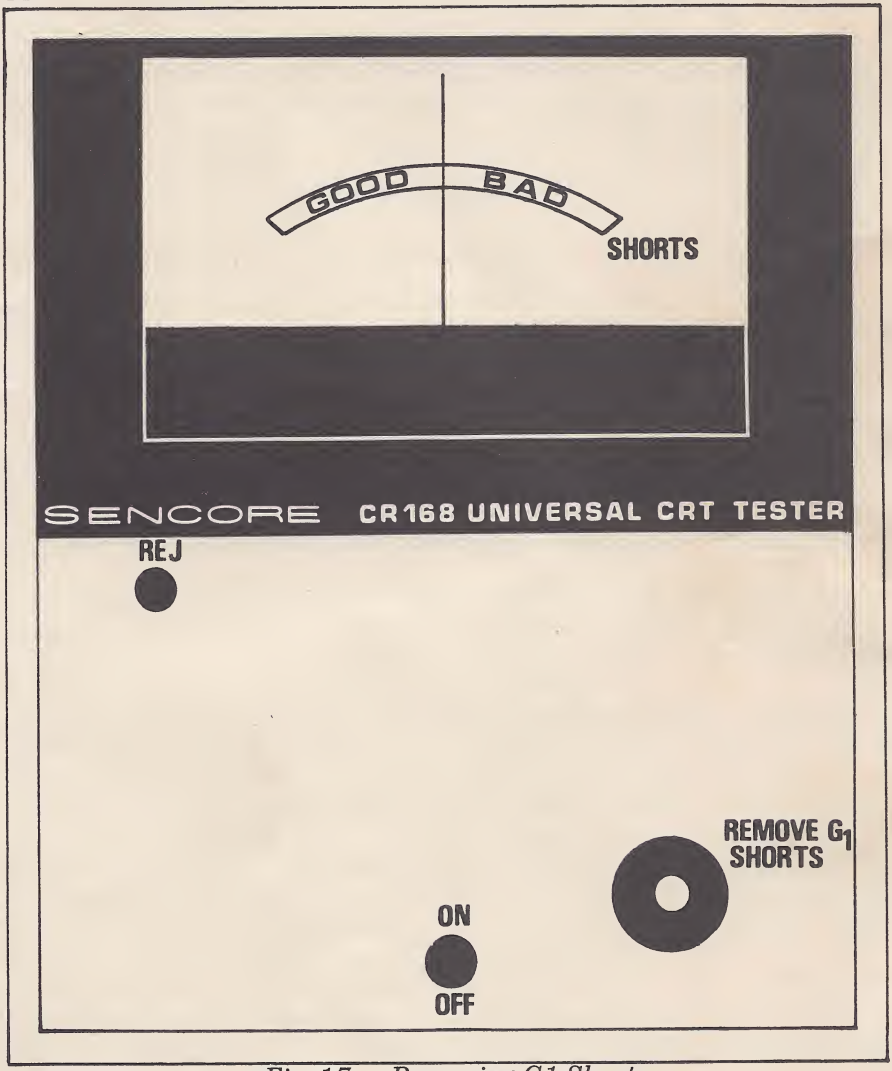


Fig. 17 Removing G1 Shorts

between the control grid and G2/cathode, with the filament voltage removed to prevent possible damage to the cathode or filament. The power stored in this capacitor will burn away most common G1 shorts, caused by foreign matter within the tube. The discharge of the capacitor is determined by the degree of short, and, once discharged the capacitor will not apply additional power that could damage the CRT. To remove a G1 short, proceed as follows:

1. Switch the CR168 off, turn the Function switch to the REMOVE G1 SHORTS position, and press the Gun Selector corresponding to the shorted gun. IMPORTANT: Allow the filament of the CRT to cool for at least 30 seconds.

2. Switch the CR168 ON, press the REJ button, and observe the neck of the tube. If a flash occurs, turn the Function switch to the G1 SHORTS position and see if the short has been removed. If no flash occurs, press the REJ button again. If no flash occurs after several attempts to remove the short, and if the short is still present, the short is mechanical in nature and can not be removed by the CR168.

REJUVENATION

Rejuvenation is a process of accelerating the beam current and/or increasing the filament voltage temporarily to bring to the cathode surface new emitting material and enlarge the opening or aperature in the control grid. The Sencore CR168 uses a capacitive discharge system for rejuvenation, so no timing is necessary. The CRT and the capacitor automatically determine the rejuvenation time. If the REJ button is held down, the capacitor will discharge, and no further voltage is applied to the CRT unless the button is released and pressed again. This system prevents excessive rejuvenation and CRT damage which can result from powered, brute force rejuvenation methods. NOTE: Each gun of a color CRT is rejuvenated independently. Simply press the Gun Selector switch corresponding to the gun you wish to restore, and proceed with the rejuvenation operation.

If it has been determined that a brightener will restore normal operation of the CRT, (see DETERMINING THE NEED FOR A BRIGHTENER) rejuvenation is not recommended. It is good practice to inform the customer of the slight danger involved in rejuvenating any tube, and have his consent before rejuvenation is attempted. Many technicians use rejuvenation as a way to generate future business by offering to deduct the charge for rejuvenation from the cost of a new CRT installation at some future date.

The EXPANDED LIFE TEST should be performed after a CRT is successfully rejuvenated. If the CRT fails any test at the lowered filament voltage, a brightener may be necessary to insure continued per-

formance of the CRT. To rejuvenate a CRT, proceed as follows:

1. Turn the Function switch to the REJ 1 position, and press the REJ button.

2. Turn the Function switch to the EMISSION position to see if any improvement has been made. The REJ 1 operation may be repeated as often as necessary with no danger to the CRT. If emission level is still not satisfactory, proceed with step 3.

3. Turn the Function switch to the REJ 2 position, allow the filament to warm up for 30 seconds, and press the REJ button.

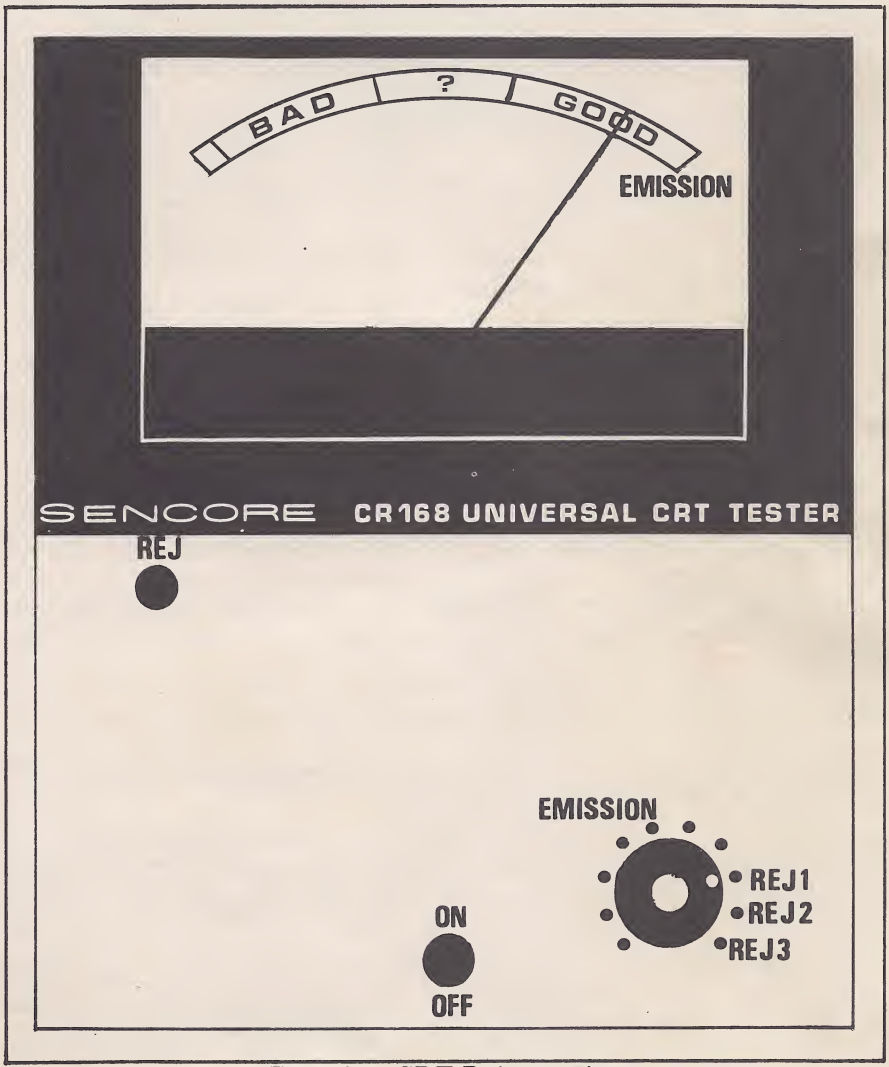


Fig. 18 CRT Rejuvenation

4. Turn the Function switch to the EMISSION position to see if any improvement has been made. For most CRT's, the REJ 2 operation can be repeated as often as necessary, however care should be taken on small neck tubes, and those with a bias setting of A or B.

CAUTION: Proceed with step 5 only as a last resort. REJ 3 should not be used on small necked CRT's, or those with a Bias setting of A or B.

5. Turn the Function switch to REJ 3, allow the filaments to warm up for 60 seconds, and press the REJ button.

6. Turn the function switch to the EMISSION position to see of any improvement has been made. If no improvement has been made, do not attempt further rejuvenation. If some improvement has been made, but the CRT still does not indicate in the green GOOD area of the meter, the REJ 3 operation may be repeated, however each time REJ 3 is used the chances of damaging the tube are increased.

NOTE: Each time the rejuvenation arc-over occurs within the CRT gun, some emitting material is dislodged from the cathode. Continued rejuvenation of a CRT will result in excessive removal of emitting material and a substantially lower emission capability.

CATHODE WELDING

If a CRT indicates absolutely no emission, and the filament is still working, this indicates an open cathode. When this occurs, the automatic controlled rejuvenation of the CR168 can be used in an attempt to weld the cathode. If the tube is an older type with solder pins on the base, these should be soldered first, as this may be the cause of the open cathode.

1. Set the function switch to the REJ 3 position, and allow the filament to heat up for at least 30 seconds.

2. Press the REJ button, and observe the neck of the CRT. If a flash occurs, release the REJ button, and turn the Function switch to the EMISSION position to check the CRT for emission.

3. If no flash occurs, press the REJ button, and tap the neck of the tube. If a flash does not occur, and no emission can be read on the meter, the cathode can not be welded to restore performance.

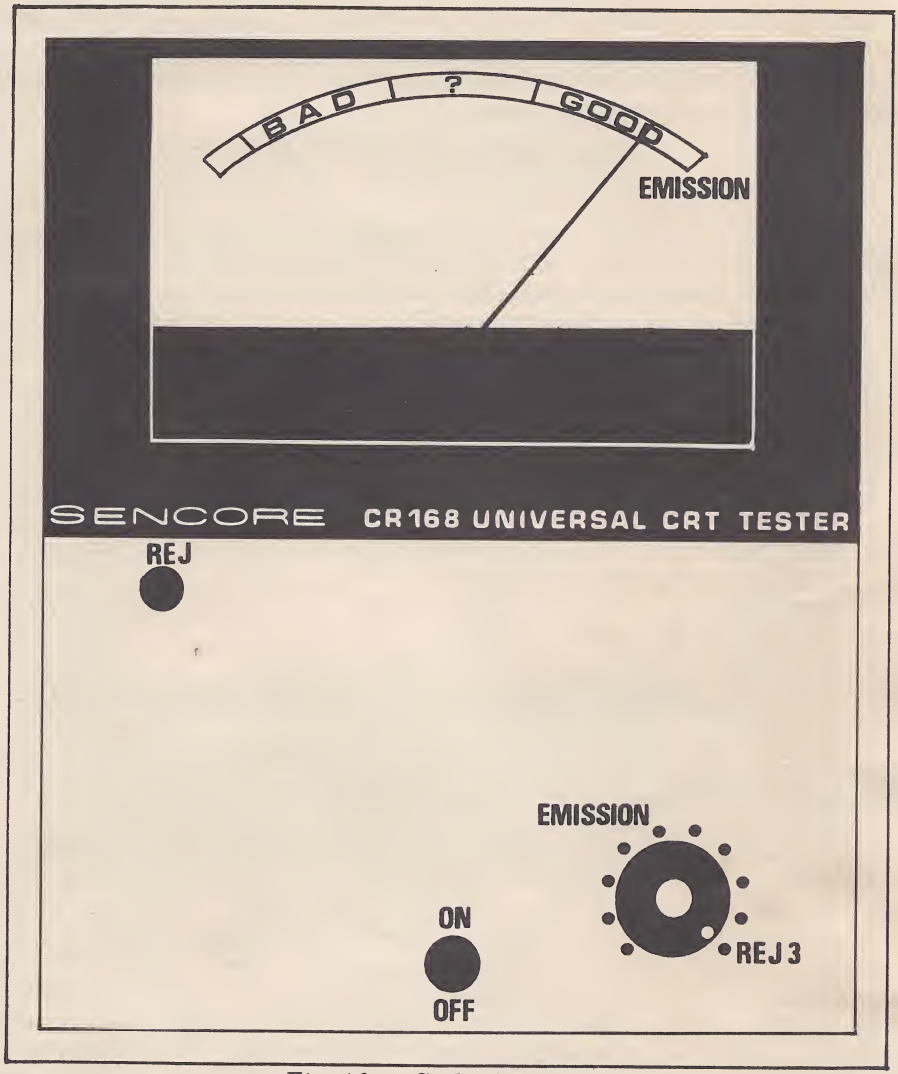


Fig. 19 Cathode welding

NEW CRT SET UP BOOKS

New CRT Set Up Books are printed at regular intervals for the CR168 Universal CRT tester. To receive this up to date information, sign the warranty card enclosed with this instrument, and return the signed card to the Sencore Central West Sales and Service Office, 3200 Sencore Drive, Sioux Falls, South Dakota 57107. Your name will then be placed on an automatic mailing list to receive each new chart as it is printed. You will be billed a small charge to cover printing and handling for each chart received.

If you encounter a new CRT that is not listed in the set up book, contact the Sencore Central West Sales and Service office in Sioux Falls. A complete list of up-to-date information on new CRT's is maintained in a card file at this office to assist you.

NEW CRT ADAPTORS

Space has been provided in the cover of the CR168 for new tube adaptors should the need arise. If a new tube is announced, an adaptor and information on this tube is available from the Sencore office nearest you. You may also wire an adaptor yourself by obtaining a socket and wiring it according to the schematic diagram. The plug used on the CR168 socket is an Amphenol 86-CP11 or equivelant.

CR168 CIRCUIT DESCRIPTION

1. Filament circuit for all tests
2. Power supply
3. Shorts Test functions
4. Gun balance, Emission, and Tracking functions
5. DC voltage circuits in REMOVE G1 SHORTS and REJ functions.

FILAMENT CIRCUIT FOR ALL TESTS

The CR168 Filament transformer (T2) is multitaped on both the primary and secondary sides. The taps of the secondary winding are connected to SW6 the coarse FILAMENT VOLTAGE switch. SW6 selects the correct secondary tap, and couples it through red/black, red/yellow, and red/green wires to pin 11 of the adaptor socket. The output of SW6 is also coupled through a white/yellow/black wire to R9 and R10 on SW2. The common lead of the secondary winding (green wire) is connected directly to CR3, and through a jumper wire to CR2. The jumper also connects to pin 1 of the adaptor socket through red, brown and black wires. When the common secondary lead is negative, current flows through CR2, SW2F, R11, M1, SW2G, and R10 to the wiper of SW6. When the wiper of SW6 is negative, current flows through R9, SW2F, R11, M1, SW2G, and CR3 to the common secondary lead. Thus on each half cycle or the applied AC voltage current flow through M1 in the normal negative to positive direction, with a 24.7K resistor in service with it.

The common primary winding of T2 (L5) is permanently connected to the low side of the AC line. The hot side of the AC line is connected through the ON-OFF switch to the wiper of SW2A (rear of wafer 4).

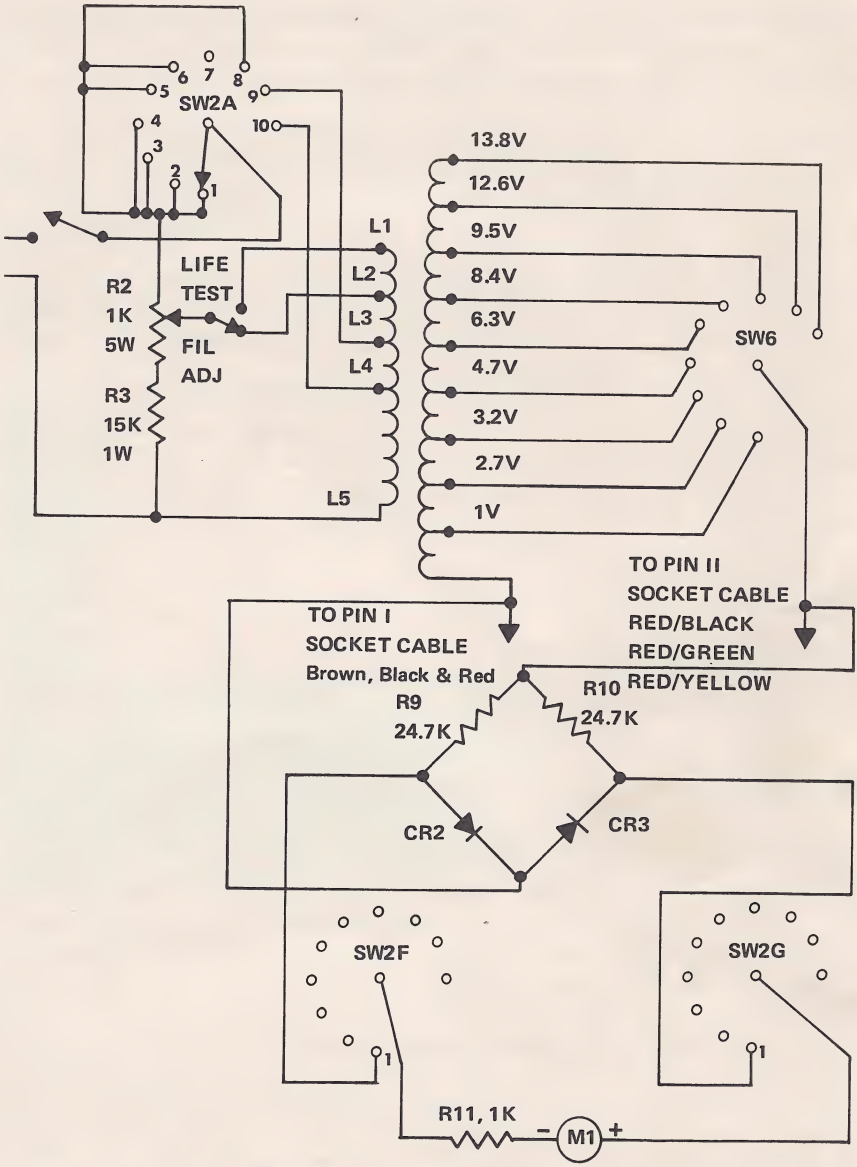


Fig. 20 Simplified Filament circuits

SW2A selects the primary taps (L1 - L4) to provide the filament voltages required by different functions. Positions 1, 2, 3, 4, 5, 6 and 8 of SW2A connect the AC input to the filament adjust voltage divider composed of the fine FIL VOLTAGE control (R2), and R3 (15K).

In normal operation (LIFE TEST pushbutton out) the wiper of R2 is connected to the L2 tap of T2, producing the filament voltages indicated

on the schematic. With the LIFE TEST pushbutton depressed, the wiper of R2 is connected to the L1 tap of T2, providing filament voltages approximately 15% lower than those shown on the schematic.

In position 7 of SW1A, (REMOVE G1 SHORTS) the AC input is not connected to any of the primary taps. This removes the filament voltage and allows the CRT filament to cool for the REMOVE G1 SHORTS function.

In position 9 of SW1A, (REJ 2) the AC input bypasses the filament adjust voltage divider, and is connected directly to the L3 tap of T2. This connection provides filament voltages approximately 20% higher than those listed on the schematic.

In position 10 of SW1A, (REJ 3) the AC input again bypasses the filament adjust voltage divider, and is connected to the L4 tap of T2. This connection provides filament voltages approximately 35% higher than those listed on the schematic.

POWER SUPPLY CIRCUIT

The output of the secondary of T1 (180V RMS) is rectified by CR101 and filtered by C101 to produce a positive 225 volt output. The output of T1 is also rectified by CR102 and filtered by C102 to produce a negative 225 volt output.

The sum of the two outputs (450 volts) is connected to the rejuvenate capacitor, C1 and to a voltage divider to produce the various voltages required by the CR168. Starting from the anode of CR102 current flows through the 68 volt zener (CR104) in parallel with the bias voltage divider (R4-R6 and R11). The positive side of CR4 is the zero voltage reference for the CR168. From the zero reference current flows through the 20 volt zener (CR103). The positive end of CR103 provides the plus 20 volts to power the FET circuits of the CR168. From the positive 20 volt point, current flows through the shorts voltage divider (R103 and R104) in parallel with the G2 controls (R106, 107 and 108) to the cathode of CR101. The output of the shorts voltage divider (junction of R103 and R104) is 100 volts positive DC, used for Shorts test functions of CR168.

NOTE: If regulation problems are encountered in the 68 volt zener, check the G2 controls and the shorts voltage divider for an open circuit.

SHORTS TEST

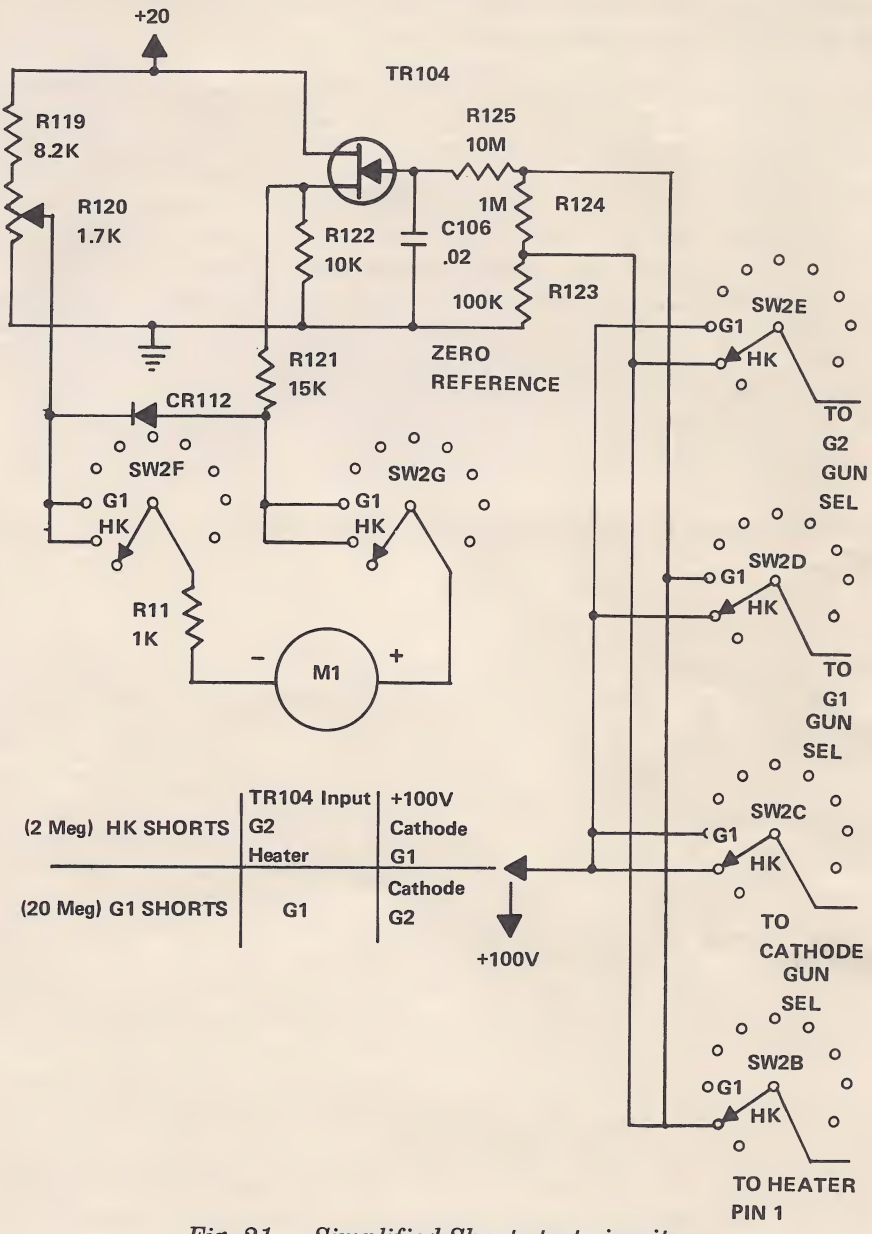


Fig. 21 Simplified Shorts test circuits

With no CRT connected to the CR168, the gate of TR104 is at the same potential as the zero reference, and the source at some positive value as

determined by the I_{DSS} characteristics of the FET. R120 (1.7K) is an internal meter zero control that is factory adjusted for zero current through the meter (voltage equal to source of TR4).

The CR168 shorts test applies 100 volts DC from the shorts test voltage divider in the power supply between the elements of the CRT being tested. Any current that flows as a result of shorts or leakage also flows through one or both of the sensing resistors in the gate of TR104. This shorts or leakage current produces a positive voltage at the gate of TR104. TR104 couples this positive voltage to M1, causing M1 to read up scale. In the H-K shorts test, the leakage current flows through R123 (100K) only, and a leakage of 2 meg ohms will cause a mid-scale indication of M1. In the G1 shorts test, the leakage current flows through both R123 and R124, and a leakage of 20 Meg ohms will cause a mid-scale indication on M1. The table in Fig. 21 lists which CRT elements are connected to the inputs of TR104.

GUN BALANCE AND EMISSION CIRCUITS

The GUN BALANCE, EMISSION and TRACKING tests are all related, and use much of the same circuitry. Fig. 22 is a simplified drawing of the applied voltage and metering circuits during the GUN BALANCE test. Current flows through R112 the 6.8K resistor, through SW2C, and the gun selector switch to the cathode of the gun under test. Current flows through the gun being tested, to G2, and back into the CR168 through the gun selector switch and SW2E. From SW2E, current flows through SW2F, M1, R11, SW2G, and the gun selector switch to the wiper of one of the G2 controls. A negative voltage, as selected by the BIAS switch, is applied to G1 of the gun under test through R12, SW2D and the gun selector switch. During the GUN BALANCE test, the G2 control is adjusted for a small (20uA) current through M1. This test is used to determine cut off characteristics of the CRT, and to establish a reference current for testing the three guns of a color CRT.

The only change in Fig. 22 for the emission test, is that the negative bias is removed from G1 of the gun being tested, and the G1 is connected to the cathode through R7, 47K. Removing the bias increases the current flow through the gun under test, and M2 leads the zero bias emission current. The zero bias emission current also flows through R112, 6.8K. As each of the three guns of a color tube is tested for emission, the voltage produced by the current flow through R112, 6.8K is used to charge the memory capacitors (103, 104 or 105) selected by the gun selector switch.

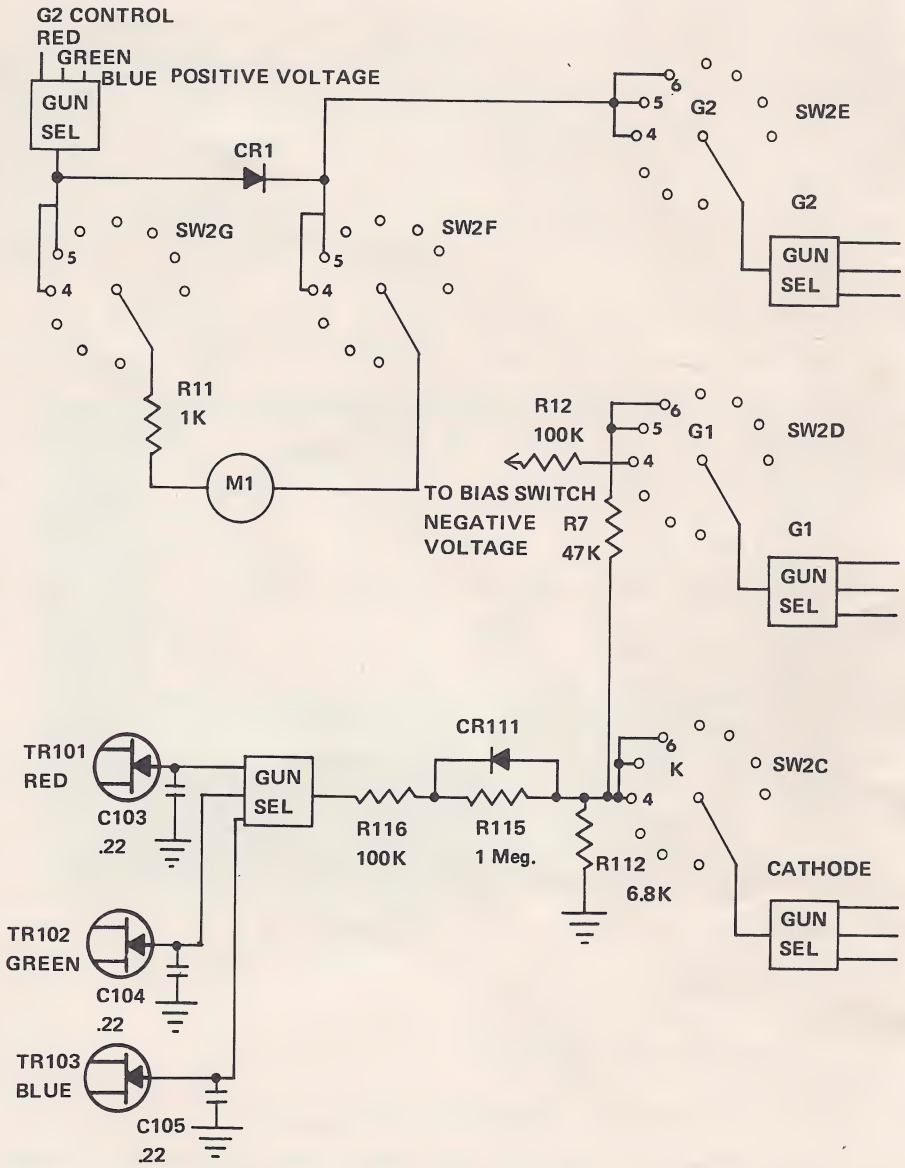


Fig. 22 Simplified Gun Balance and Emission test circuits

TRACKING CIRCUIT

During the emission test the memory capacitors in the gate circuits of TR101, TR102 and TR103 are charged to a voltage proportional to the emission of each gun. During the tracking test, the FET's function as very high input impedance source followers, transferring the gate voltage to the source without changing the gate voltage.

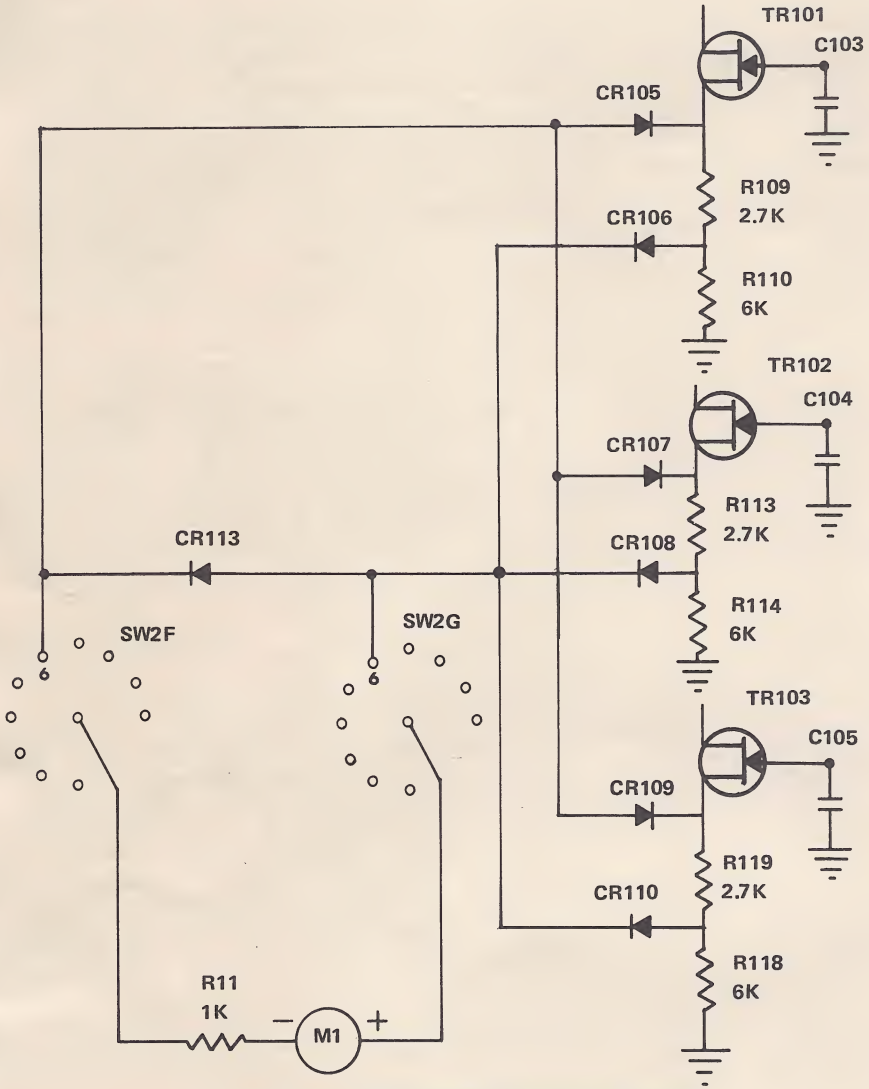


Fig. 23 Simplified Tracking circuits

If the voltage at the junction of the two source resistors in any one of the three FET source followers exceeds the voltage at the source of any other FET, two of the steering diodes CR105 to CR110 will be forward biased, allowing current to flow through M1. FOR EXAMPLE: During the emission test the gate of TR101 is charged to 10 volts, the gate of TR102 charged to 8 volts, and the gate of TR103 charged to 6 volts. The source followers transfer the gate voltages to the source. The voltages at the junction of the source resistors would then be 6.9 volts for TR101, 5.5 volts for TR102, and 4.1 volts for TR103. In this example the vol-

tage at the source of TR103 was 6 volts, and the voltage at the junction of the source resistors of TR101 was 6.9 volts. The forward biases CR 106 and CR109, allowing current to flow through M1, indicating that the color CRT in the example has bad tracking.

REMOVE SHORTS AND REJUVENATE CIRCUITS

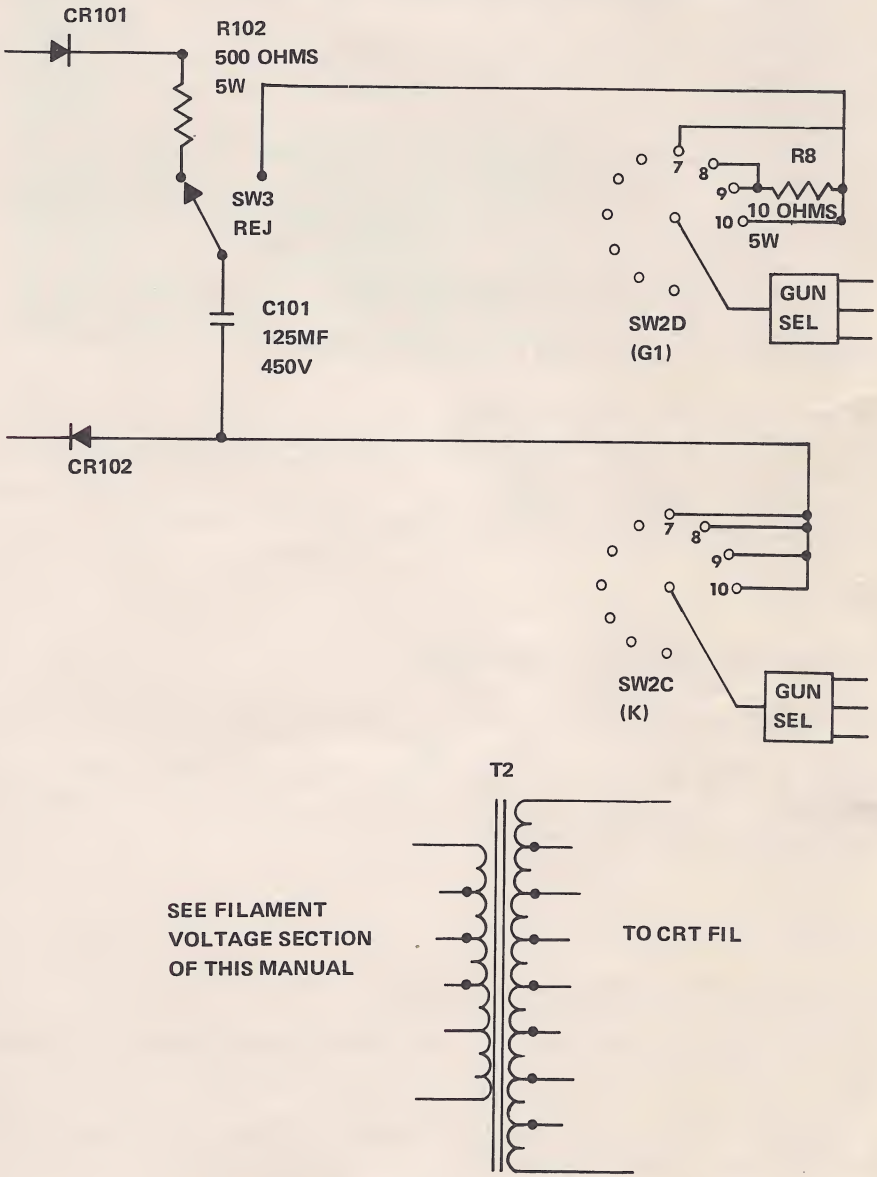


Fig. 24 Simplified Rejuvenation circuits

The remove shorts, and rejuvenation functions all depend on the discharge of a large (125mF) capacitor. In the Remove shorts function (pos 7 of SW2) the filament voltage is removed from the CRT, and the capacitor is discharged directly between G1 and G4 cathode. The heavy discharge current will burn away most G1 shorts, and because the cathode is cooled, there will be no danger of giving the tube unwanted rejuvenation. In REJ 1 and REJ 2, the capacitor is discharged to G1 through a 10 ohm resistor, limiting the peak current to a value that is safe for all CRT's the filament voltage for REJ 1 is the normal voltage as set by the filament adjust control, and in REJ 2 the filament voltage is increased by approximately 20%. In REJ 3, the capacitor is discharged directly into G1, and the filament voltage is increased by approximately 35%. REJ 3 provides the highest level of rejuvenation, and should not be used on tubes whose bias setting is listed as A or B in the CR168 Set Up Book.

SERVICING YOUR CR168

REMOVING THE CR168 FROM ITS CASE

Remove the CR168 cover containing the socket adaptors from the case. Place the CR168 face down on a soft cloth, and remove the four screws from the rear of the case. Turn the CR168 face up, slide the CR168 to the left until it is centered in the case, and lift it up and out of the case. To replace the CR168 into its case, reverse the above procedure.

CALIBRATION INSTRUCTIONS

STATIC METER ZERO

Switch the CR168 off, and using a thin blade screwdriver, adjust the static meter adjustment screw to position the meter pointer to zero on the left hand edge of the meter.

SHORTS TEST ZERO ADJUST

1. Remove the CR168 from its case.

2. Turn the Function switch to H-K SHORTS, and switch the CR168 ON.

3. Adjust R120 (shorts zero adj.) to position the meter pointer to the left hand edge of the meter.

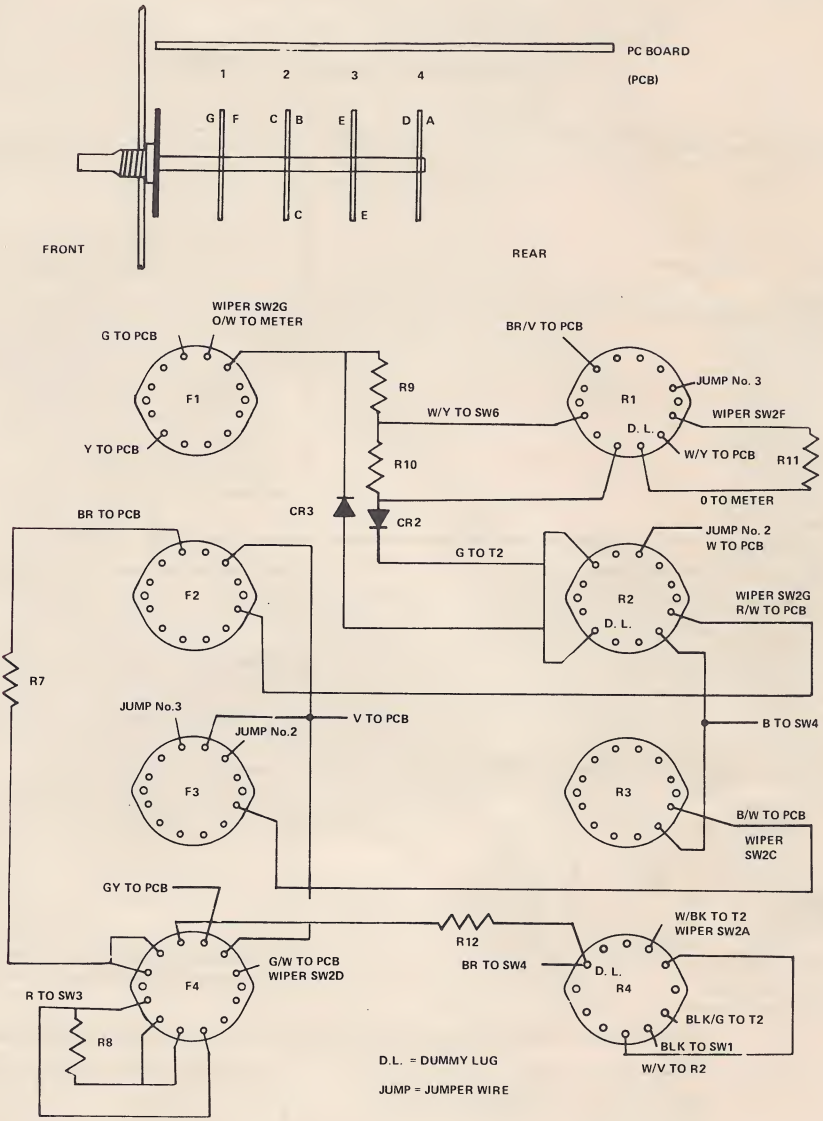
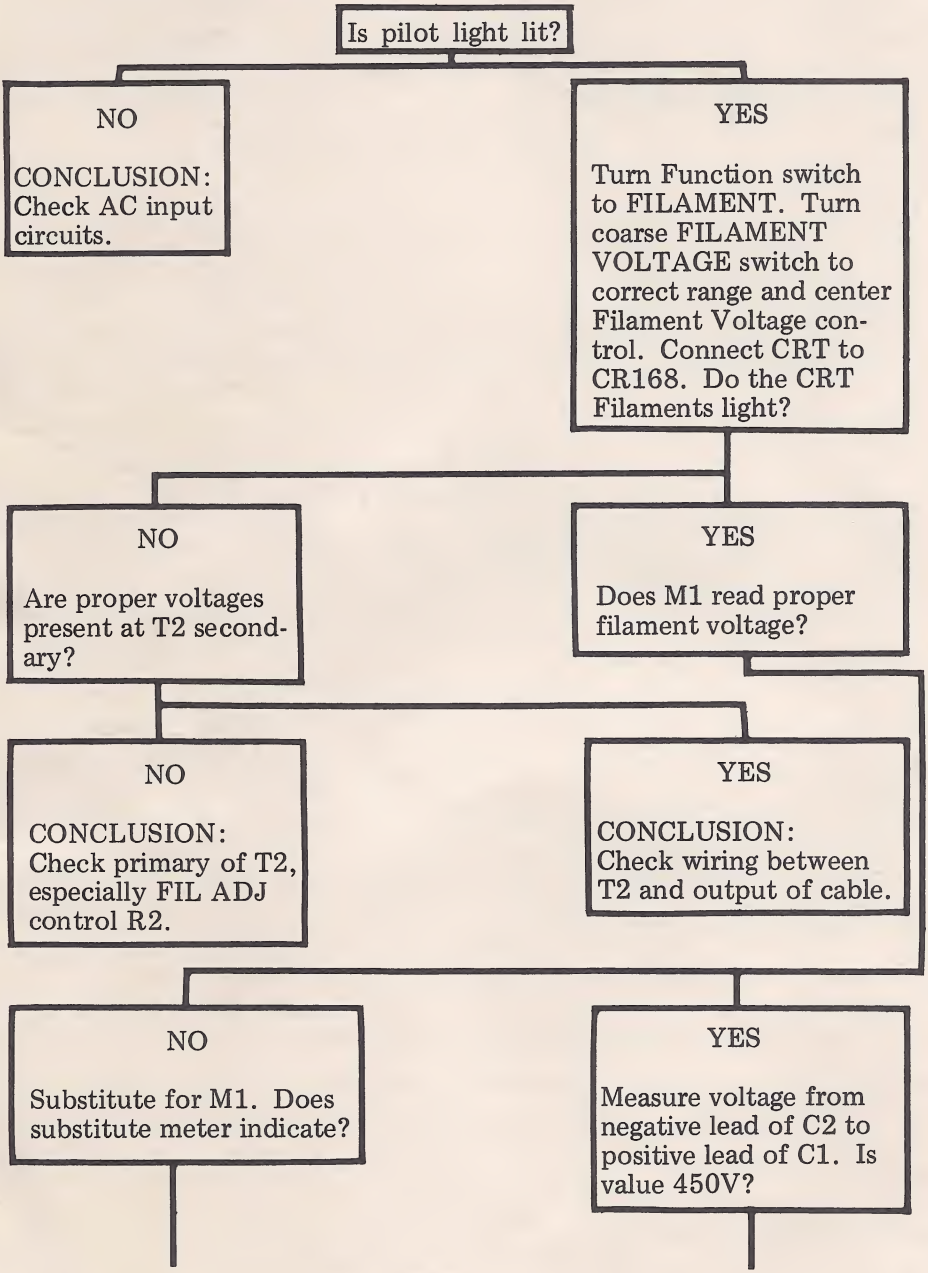


Fig. 25 Function Switch

TROUBLE CHARTS

NOTE: Be sure to check several tubes using different sockets to be sure that a defective adaptor is not cause of the problem.

CR168 INOPERATIVE - ALL TESTS



NO

CONCLUSION:
Check wiring of SW1F and SW1G, R9, R10, CR2, and CR3.

YES

CONCLUSION:
Replace M1.

NO

CONCLUSION:
Check T1, R101, CR101, R105, CR102.

YES

CONCLUSION:
Turn Function Switch to GUN BAL, press R/B&W Gun Selector, turn BIAS switch to A, and R/B&W G2 to center of rotation. Connect common lead of FEM to pin 2 of adaptor cable and measure voltage as follows:
Pin 8: -18V
Pin 4: 150V approx.
If proper voltages are not present, use simplified drawing of Gun Balance test to locate defect.

FILAMENT VOLTAGE

Does not read correctly on meter

Turn function switch to FILAMENT VOLTAGE, connect AC Volt Meter to pins 11 and 1 of adaptor cable, and adjust FILAMENT VOLTAGE controls for 6.3 volts as measured on the AC volt meter. Do the FIL VOLTAGE controls operate normally?

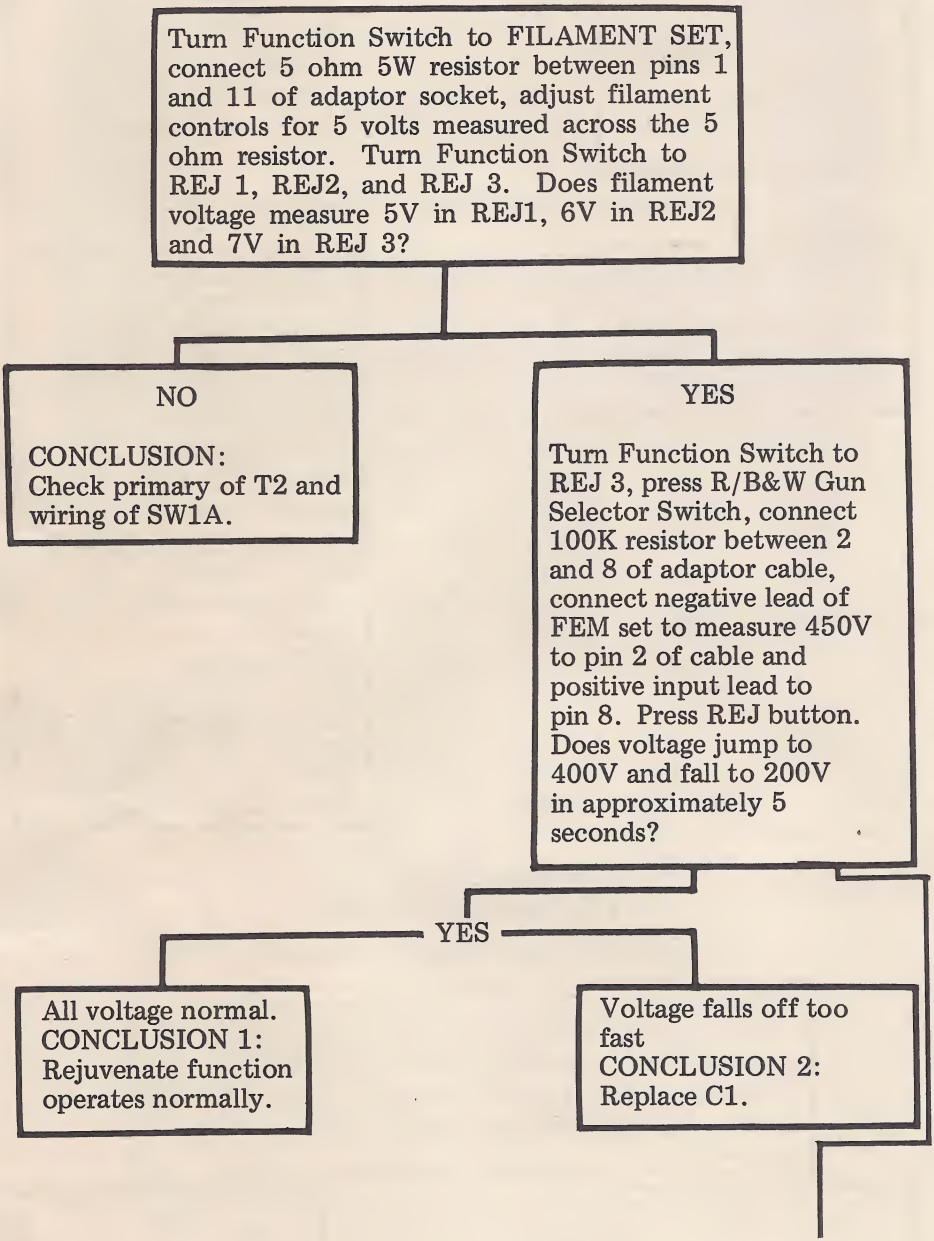
NO

CONCLUSION:
Check Filament Voltage switch and FIL ADJUST control.

YES

CONCLUSION:
Check R9, R10, CR2, CR3 and associated wiring on function switch.

REJUVENATION FUNCTIONS INOPERATIVE



NO

Check for -68V on wiper of SW1C and 390V on wiper of SW1D with respect to zero reference, and the REJ button pushed; are voltages normal?

NO

Measure voltage from black to red leads of C1 (450V). Is voltage normal?

YES

CONCLUSION:
Check push on connectors at Gun Selector switches and cable wiring.

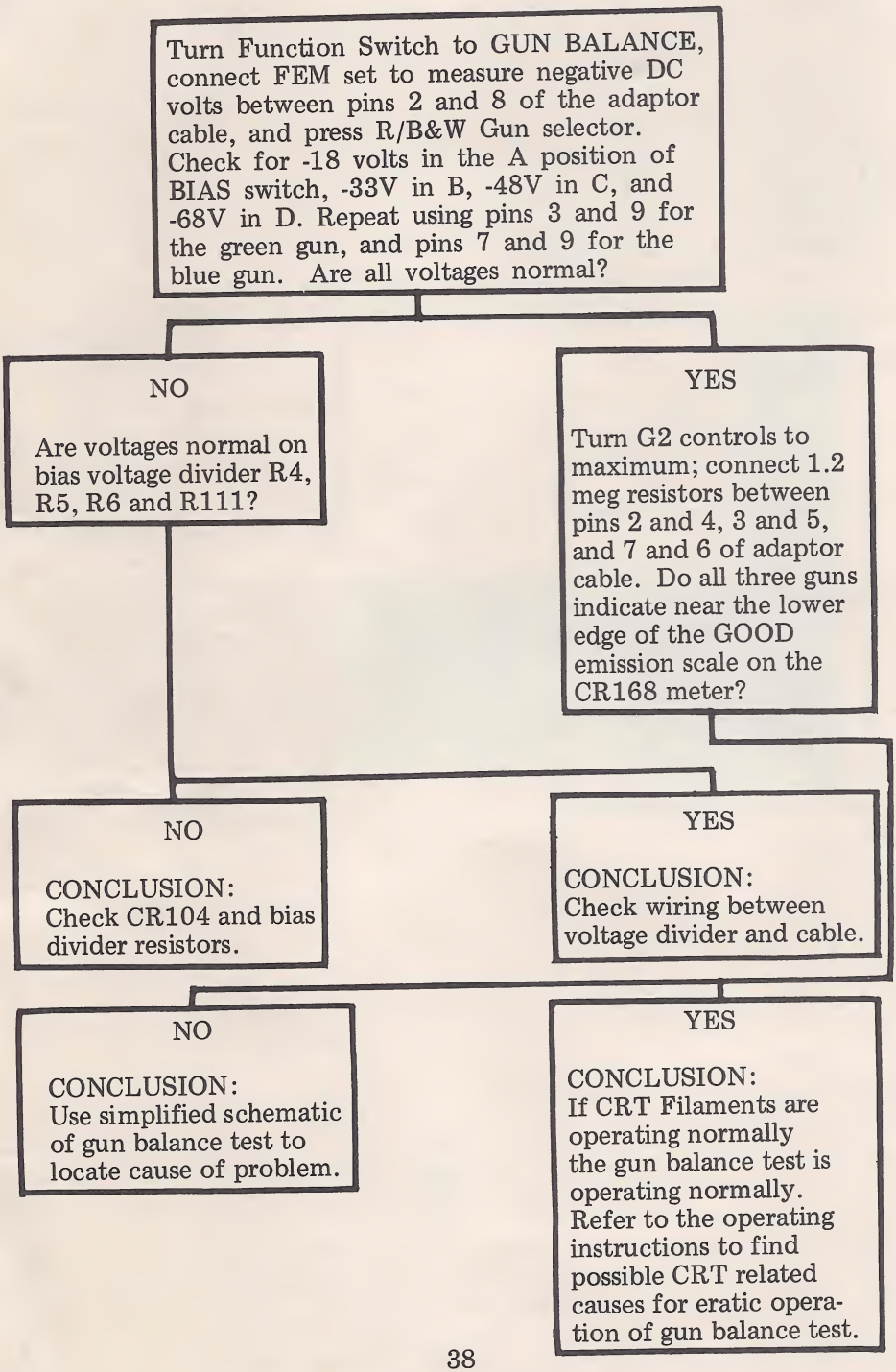
NO

CONCLUSION:
Check wiring from PCB to C1, REJ switch & R102 on PCB.

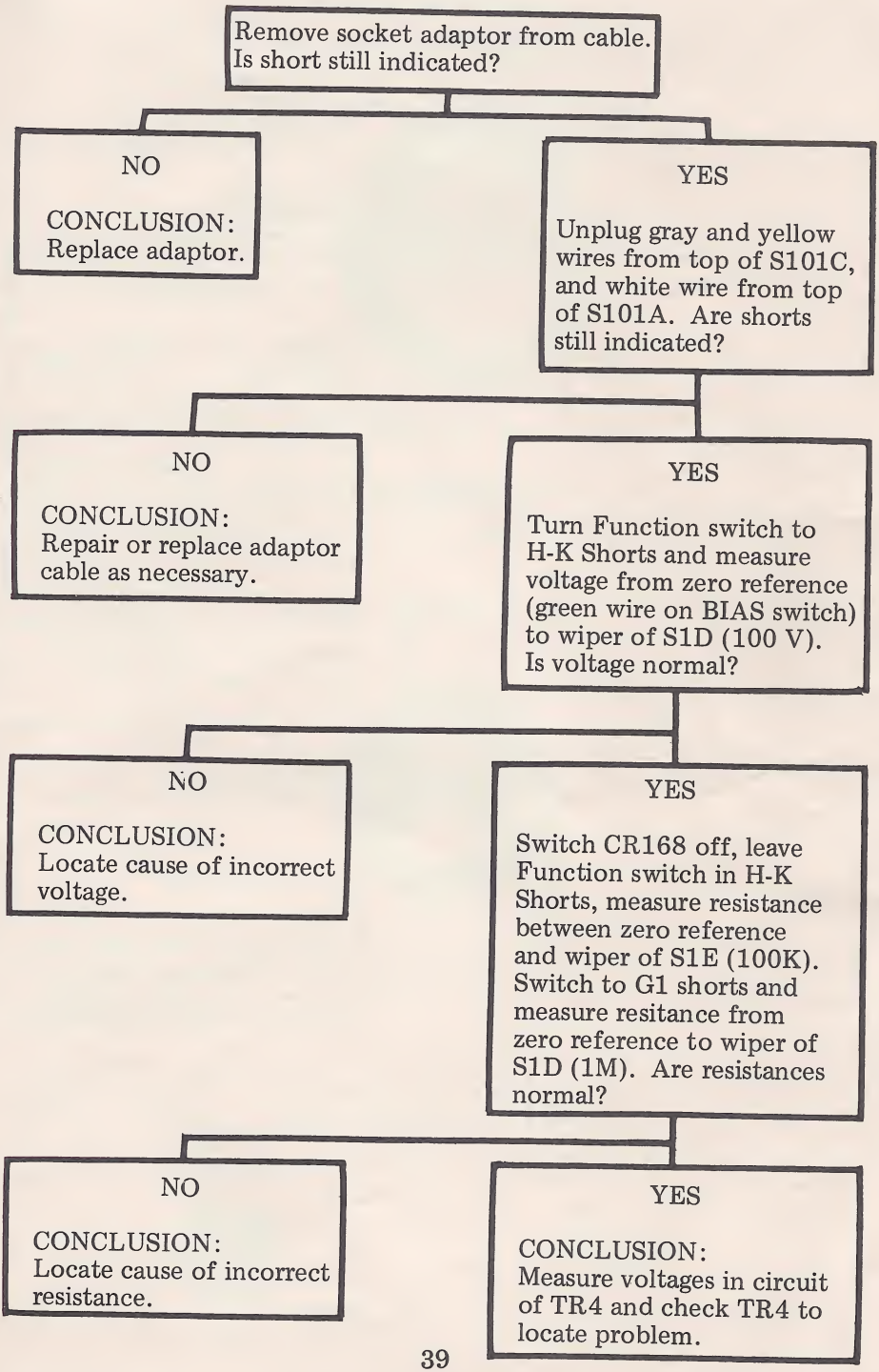
YES

CONCLUSION:
Check REJ switch and wiring from C1 to Function switch.

GUN BALANCE ERATIC OR INOPERATIVE



ALL CRT'S TEST SHORTED



ALL COLOR TUBES TEST BAD TRACKING
(Emission and Gun balance tests normal)

Connect 150K resistor between pins 2 and 4, 3 and 5, and 7 and 6 of the socket adaptor cable. Turn the G2 controls to maximum, and set the function switch to EMISSION. Press each of the Gun Selector buttons and observe the meter. Do all 3 guns test near full scale on the meter?

NO

CONCLUSION:
Follow procedure for defective emission.

YES

Measure the voltage at the source of TR101, 102, 103. Are voltages all within 10% of each other? (11V)

NO

CONCLUSION:
Check FET where source voltage is different, also FET drain voltage and Gun Selector switch going to gate of FET.

YES

Measure the voltage at the junction of the 2 source resistors for TR1, 2, & 3. Are voltages all within 10% of each other?

NO

CONCLUSION:
Check the source resistor, CR5 - CR10, and associated wiring.

YES

CONCLUSION:
Check wiring for abnormal source of voltage to M1 while in tracking position of Function switch.

EMISSION TEST READS TO HIGH OR TOO LOW

Connect 1.2meg resistors between pins 2&4, 3&5, 7&6 of adaptor cable. Turn G2 controls to maximum. Does emission test for all three guns read near the bottom of the GOOD area on the edge of the EMISSION scale?

NO

CONCLUSION:
If one gun only reads incorrectly, check G2 voltage and connections for that gun. If all three guns read incorrectly, check CR12, M1 and associated wiring.

YES

CONCLUSION:
If filament voltage is correct, emission test is correctly calibrated. Refer to operation section of manual for probable CRT related causes.

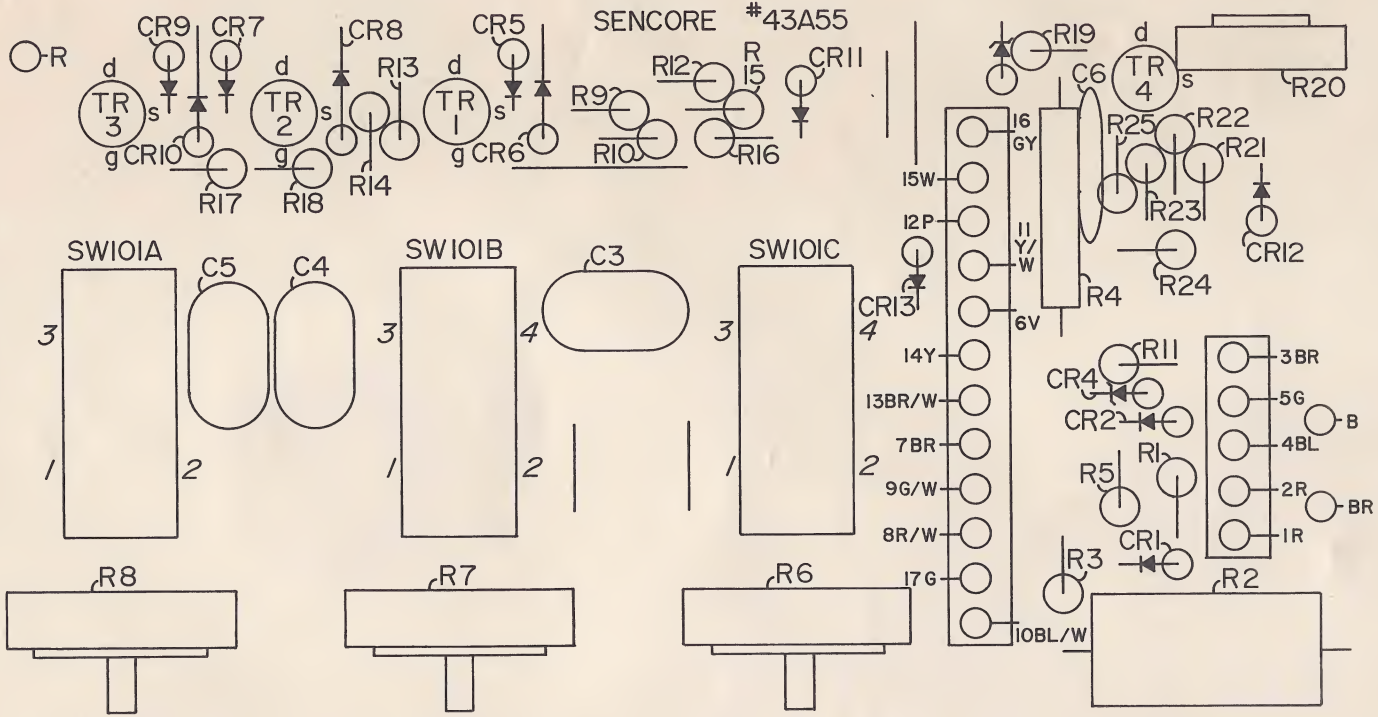


Fig. 26 Component side view

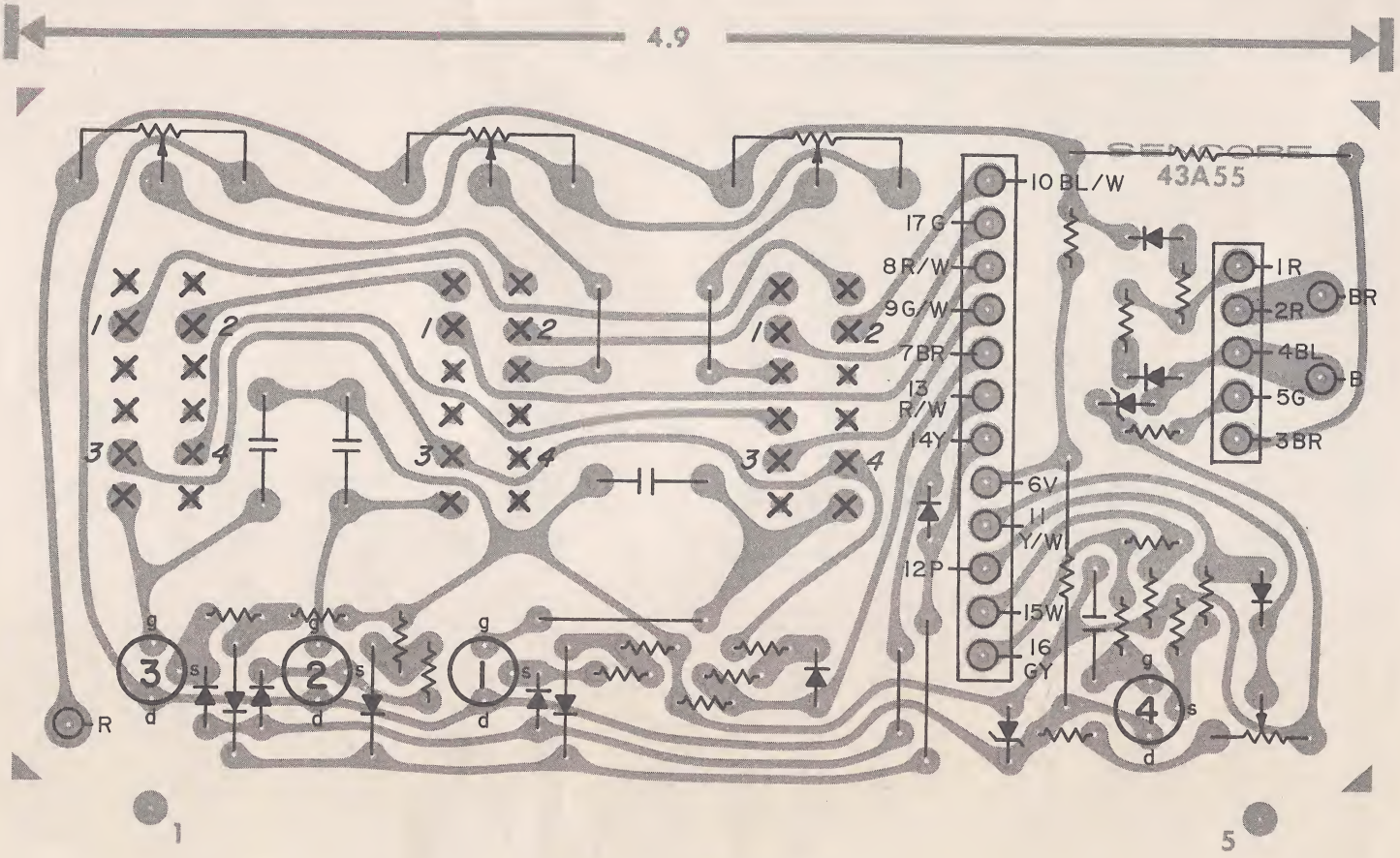


Fig. 27 Foil side view

SERVICE AND WARRANTY

You have just purchased the finest CRT tester on the market today. The Sencore CR168 has been inspected and tested twice at the factory and has passed a rugged use test by our Quality Assurance Department to insure the best quality instrument to you. If something should happen, the CR168 is covered by a standard 90 day warranty as explained on the warranty policy enclosed with your instrument.

Sencore has five regional offices to serve you. Instruments to be serviced should be returned to the nearest regional office by UPS if possible. Parcel post should only be used as a last resort. Instruments should be packed with the original packing materials or equivalent, and double boxed to insure safe arrival at the regional office. The display carton is not an acceptable shipping container. When returning an instrument for service, be sure to state the nature of the problem to insure faster service.

If you wish to repair your own CR168 CRT Tester, we have included a schematic, trouble chart, and parts list. Any of these parts may be ordered directly from the regional office nearest you.

We reserve the right to examine defective components before an in warranty replacement is issued.

SENCORE REGIONAL OFFICES

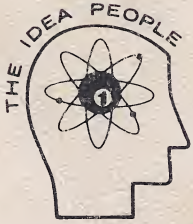
Sencore East Central Sales and Service
4105 Duke
Alexandria, Virginia 22304
A/C 703 751-3556

Sencore Central Sales and Service
2711 B Curtis St,
Ellsworth Ind. Park
Downers Grove, Illinois 60515
A/C 312 852-6800

Sencore Central West Sales and Service
3200 Sencore Drive
Sioux Falls, South Dakota 57107
A/C 605 339-0100

Sencore Western Coast Sales and Service
833 Mahler Road
Burlingame California 94010
A/C 697 692-5854

Sencore Southeastern Sales and Service
3459 Roosevelt Hway Suite B9
College Park, Ga. 30337
A/C 404 768-0606



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